POWER

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BIRD IN HAND

• HALF A LOAF is better than none. A bird in the hand is worth two in the bush. A good modernization start in the boiler room is worth a brand new power plant in the filing cabinet.

• MOST POWER ENGINEERS know that their plants are not up to snuff. Most of them have a fair idea of the kind of plant they would like to run. But their dream of an ideal plant, cranking out steam and juice at rock-bottom cost, never comes true—the investment pill is too big for the management to swallow. So losses go on forever.

• EXPERIENCE POINTS THE WAY OUT. This way, attuned to the facts of human nature and industrial finance, is "step-by-step modernization."

• YOU CAN'T HAVE A NEW PLANT now, let's say, and that's all there is about it. But how about having a modern plant five years from now, and getting the first half—or quarter or tenth—of it now? And how about having that present fraction the part that will make the biggest showing in dollars-and-cents power-cost savings?

• WHAT ARE THE STEPS? First, tour your plant, spotting losses—potential savings. Do it systematically. Write down the estimated savings from each modernization step. Write down also what equipment is required, what it would cost installed. Figure the per cent return on the investment, and the years, or months, required to pay out. Finally, check this: Will the single steps fit into future plans, become worthy parts of the larger and better plant?

• WITH THESE ITEMS DOWN on paper, segregate those of immediate interest. Bring together the items that pay out quickly. From these select those whose investment is within reason, considering present company finances. Then get started.

• SOMETHING MORE THAN MERE ECONOMICS enters here; there is a problem in psychology. The engineer must prove to management the soundness of his own ideas. What better way than to start with moderate investments that pay out in a few months? The confidence thus won builds a foundation for bigger steps to come.

• TO HELP THE POWER ENGINEER put this idea into effect, *Power* devotes the next seven pages to an outline of the possible steps—an assembly of practical hints. No details, just suggestions for the man already familiar with power problems.

• WITH THESE IN HAND, walk through your plant. Check the items on page 620. Get started!

STEP-BY-STEP MODERNIZATION OF

STEAM GENERATION

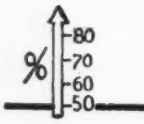
FIRST THINK ABOUT PRESSURE

1. Your boiler-room problem is one of cheap steam, enough of it, and *at the right pressure*. Watch your step before you modernize a boiler at your present pressure. Study page 616. Will your present steam pressure fit into future plans for by-product power? Will a sound plan call for 300 lb. or 500 lb. in 1938? If so, should not your new boiler be designed to carry that pressure, although temporarily operated at the present low plant pressure? And how about superheat? It's an integral part of the modernization problem, so provide for the right steam temperature.

HOW ABOUT FUELS?

2. You are burning coal now. What kind? May you want to shift some day, if relative prices shift? If you modernize fuel-burning equipment, allow yourself ample longitude and latitude to use any coal you are likely to consider, and to use it with high efficiency and with little clinker trouble, and at full boiler load. Don't skimp on stoker size or pulverizer size. Otherwise, you may have trouble at high load.

Any chance of advantage by shifts among coal and oil and natural gas? If so, consider spending a few dollars more to make future changes possible.

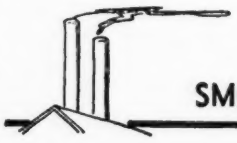


EFFICIENCY?

3. The new boiler and the revamped boiler must be efficient. You won't consider less than 70 per cent over-all efficiency today. Five years from now you may be ashamed of anything less than 80 per cent. Perhaps you should provide for 80 per cent now.

HAND FIRING

4. There's hardly any argument here; hand-firing is out on new installations. But when the shovel goes into the corner, there's still labor for maintaining equipment, for filling in the gaps of coal- and ash-handling systems. In comparing various types of equipment, remember that labor hourly rates will probably go higher in the future.

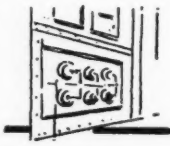


SMOKE?

5. Today you're lucky! Your town has no smoke ordinance, or doesn't enforce it. In fact, it rather likes to see smoke—"sign of returning prosperity." Or perhaps your present fuel is "smokeless." So you don't worry about smoke prevention when installing new equipment, or modernizing your boiler-settings. Then in a few years times change, and fuels change. You find yourself on the spot for smoke, and become the unlucky bird who must spend thousands of dollars in changes. Why not provide for this contingency in your present plans? And don't forget that dust and cinders, as well as black smoke, are part of the clean-air problem.

THEN THE PLAN

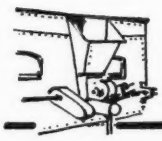
6. Right here you can stop and make a general plan of the boiler room you expect to have five years from today. Allow for possible engineering advances. Make your present partial modernization a part of this future picture. Don't put in stuff you will have to throw away in 1938.



ONE GOOD BOILER

7. Each modernization plan is "different," but boiler room plans often start with one good boiler. Generally it works this way: You start with a string of low-capacity, inefficient, labor-wasting boilers. You rip out one or two, carrying the load with the rest. In the new space you erect a modern unit, carrying the load of two or three of the old units. This new unit may be a high-pressure boiler temporarily operated at lower pressure. It is operated to carry the main load, leaving the old inefficient units for the "edges," and for standby. The cost of steam drops at once. The road is clear for later replacement of the remaining old units. And the plant is never shut down for changeover.

Perhaps your present boilers are O.K. for pressure and capacity, and all you require is better efficiency, plus mechanical firing. Then take them one at a time. Build new furnaces. Reset higher if necessary. Consider water or air cooling, or a combination.



MECHANICALLY FIRED

8. Of course, but how? Again line up your possible fuels. Consider relative costs and evaporations. Then consider stokers (overfeed, underfeed, chain grate, etc.) and the various systems of pulverized-fuel firing. Which gives you greatest fuel selection flexibility? How about relative efficiency, power and labor for operation and maintenance, relative reliability?

For oil, compare mechanical burners with steam jet and air jet. Allow for consumption of power, steam or air.

WITH HEAT RECOVERY

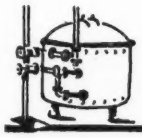
9. Right here you'll have to decide whether you want economizers, air heaters or both. There is no standardized answer. It depends on your heat balance and other local conditions. But remember that many of the modern central stations get large steam output from small water-heating surface by making the boiler mostly air heater and economizer. Thus, adding an economizer and air heater to a reset old boiler may increase its capacity as well as its efficiency. The final decision should be checked by a boiler specialist; this is no place for a hit-or-miss answer.

AND SMOOTH-WORKING GADGETS

10. Your own experience will guide you in selecting dependable boiler accessories: non-return valves, safety valves, blowdown valves, water columns, gage glasses, steam purifiers, feed-water regulators, etc. Keep out of trouble by selecting the right "nameplates."

PAVE THE FUEL HIGHWAY

11. When installing fuel-handling equipment, you may find it best to provide now for the final plant. Make close estimates of future coal requirements, and of probable final boiler-room design. Analyze the various coal-handling systems with great care. Present selection will affect future steam costs.



DRINKING WATER FOR BOILERS

12. Decide once and for all on good feed water. You'll want it for the new boilers, and might as well supply it to the old. You can therefore install now your final water purification system. Consider the reputable systems of hot process, zeolite and internal treatment. Consider also evaporators if your make-up percentage is small. Better consult a water specialist.

GOOD AND HOT

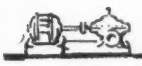
13. Is your open feed-water heater good for 212 deg.? Does it deaerate? If not, will it pay to replace it now with a modern deaerating open heater? This will still leave room to superimpose a high-temperature closed heater for future high-pressure operation.

INSTALL EYES AND EARS

14. In the class of quick-pay, low-capital investments, place recording and indicating instruments, particularly those for flue and feed temperatures, steam pressures and temperatures, steam flow and feed-water flow. Also boiler meters and other combustion instruments. These can be put in even if no boilers are to be installed or modernized. They can be shifted to new equipment later. They are as adaptable as a screw driver.

MECHANICAL BRAINS

15. Look into systems of automatic combustion control and other automatic control to replace the usual hand regulation in the boiler room. It often pays handsomely, particularly where a new modern boiler unit is installed with it. Consider cost and savings for present and future applications.



AUXILIARY DRIVE

16. The plant that wastes exhaust steam must often blame wasteful boiler-room auxiliaries, particularly steam-eating duplex steam pumps. So consider electrically-driven centrifugals, unless process and heating demand will consume all exhaust the year round. The old steam pump may be kept for standby.

DECENTRALIZATION

17. Do you need just a little process or heating steam in a distant building? Perhaps a small automatic oil- or gas-fired boiler on the spot will give cheaper service than a long, costly, B.t.u.-wasting steam line from the main boiler room.

WITHOUT SHUTDOWN

18. Hundreds of boiler plants have been modernized step by step and, ultimately, from crown to toe, without ever shutting off steam service. Study technical journals to see how others have done it, if you don't happen to know from your personal experience.

HAVE A PLAN

● "STEP-BY-STEP" does not mean "hit-or-miss." Plant modernization, whether done piecemeal or at one stroke, calls for a plan.

When you install modern instruments in an antiquated boiler room, you do so because they save you money right now, and also because you know they will serve equally well when the old boilers have been junked to make place for new.

When you put in a single new boiler, to pull for a while with old units, you do so with future trends in mind. You allow for higher steam pressures where they may offer future savings. You make certain that coal-handling equipment installed for the new boiler will fit into the ultimate boiler-room plan.

If a diesel engine is to be added now, you first consider how it will fit into a possible heat balance of five years hence, allowing for probable trends, this way or that, in power and process-heat loads.

"Step-by-step modernization should, then, fit a plan, but it should be a flexible plan, a plan that can later be changed in detail to allow for new business trends, new fuel values, new labor costs, and new enginering possibilities.

This series of articles (pages 613 to 620) cannot tell you what your particular plan should be. That is a matter for each engineer to decide on the basis of his local mechanical and financial situation, and his own experience, aided by that of consultants and equipment manufacturers. These articles will aid the practical engineer chiefly by indicating a sensible approach to the problem of plant modernization under today's difficult conditions. They point to the spots where big savings are often made. They give a hint—no more—as to how these savings may be obtained. Finally they present (on page 620) a check sheet on which the reader may sum up the results of a modernization survey of his own plant.

Lay out a modernization plan insuring flexibility and progress for the next five or ten years. Survey your own plant for present money-saving steps that will fit into this larger plan as it develops. Select those steps that promise a very large return on a moderate investment, and push them through for early action.

Finally are you hedged in by restrictions imposed by industrial executives unfamiliar with the money-saving opportunities in your power plant? If so, look for the "Executive Section" in the coming Mid-December number of *Power*. It will help them, and you—and the stockholders.

PLUGGING DOLLAR LEAKS IN POWER GENERATION

MAKE OR BUY?

1. If now making power, you must figure whether you should some day buy. If now buying power you must figure whether you could make it more cheaply. Or, perhaps, fifty-fifty generation and purchase will be better than either alone. This is basic. No use doing a thing well if it is the wrong thing to do. You must compare purchased power not merely with one plan of making (say, your present plan), but with the best possible plan.

This best plan may be (not likely) straight condensing operation. It may be by exhausting or bleeding to process and heating. It may use steam engines or turbines. It may use diesel engines. And it may involve any combination of these, with or without part purchase of power.

CONSIDER YOUR HEAT BALANCE

2. This brings you to heat balance, Power against Heat. Good heat balance does *not* mean an exact balance between process steam and power, or (to put it in another way) an exact balance between available exhaust steam and low-pressure steam demand. Passing of part of boiler steam to process through a reducing valve does not mean waste, unless accompanied by condensing operation, or loss of steam to atmosphere. The safe kind of balance to get is one with a large *deficiency* of exhaust steam. This does no harm and is insurance against rising power loads in the future. To insure this deficiency of exhaust steam, consider engines or turbines of high efficiency (but not condensing), consider more efficient auxiliary drive (electrical or steam), consider higher steam pressure and lower process pressure. Investigate all of these until you hit upon a heat balance well on the safe side, unless the cost of so doing is out of line. And don't forget to study your boiler-plant problems at the same time.

NEED HIGHER PRESSURE?

3. Higher steam pressure is the key to future economy in many plants. Always consider this possibility before you modernize. Will higher pressure ultimately pay out in your plant? Can new prime movers be later adapted to higher pressure? Can they be worked tandem on the exhaust end of a later high-pressure unit? Or should steps be taken now to install one high-pressure boiler and turbine (or engine) with provision to drop to present plant pressure in an emergency?

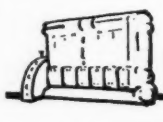
NEW ENGINES?

4. Should old corliss or slide-valve engines, or old turbines, be replaced by new economical uniflow engines? Study the effect on the heat balance. Would it be cheaper and just as good to put a new uniflow cylinder on the old engine? Or perhaps the present old engine gives insufficient exhaust the year round. In that case there is nothing to modernize.

NEW TURBINES?

5. Are the old steam turbines operating at low efficiency because of obsolete design, or wear of blades, nozzles, sealing rings, etc.? If so (as is often the case), what improvement is possible by replacing the worn parts, and at what cost? How much better would it be to buy a complete new turbine (perhaps mounted with the old generator), designed for higher efficiency, and (perhaps) for higher pressure, or adapted to changeover to higher pressure?

In considering turbines, consider separately condensing units, straight back-pressure units, bleeding and mixed pressure units. See how each fits into the present and future heat balance. Remember that the idea is to get, if possible, an excess of power supply over demand as a by-product of process and heating steam. Avoid delivery of heat to condensers or atmospheric exhaust, or at least keep it to a minimum.

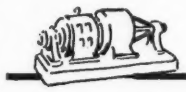


DIESEL ENGINES?

6. Don't overlook the diesel engine. It may not be adapted to your particular plant, but the steam engineer, particularly, should learn to keep it in mind. Where very little process steam is needed, a diesel may replace steam engines or turbines entirely. It may run with or without utility standby. Plants with large heating steam loads in winter may justify diesel operation in the summer. Then the steam prime movers can act also as a standby for diesels, and vice versa. Diesel engines have been improved greatly in recent years. First cost has been reduced, partly due to higher speeds.

D.C. AND 3-WIRE

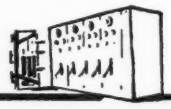
7. Are you generating D.C., 120-volt straight? Should you change to 120 and 240-volt, 3-wire? Should you do it by rewinding the old generator and installing a 3-wire balance set? Or would it be better to junk the old generator for new 120-240-volt, 3-wire machines?



D.C. TO A.C.

8. Have you an overgrown distribution system calling for A.C.? Can you justify the necessary complete replacement of distribution lines and motors? Probably only a big plant or a big expected enlargement will justify the cost. If you do change to A.C., can you economically serve adjustable-speed D.C. motors from a motor-generator or rectifier set?

Are you now supplying low-voltage A.C. to a growing system? If so, it may pay to forestall plant expansion by rewinding the generators for higher voltage to improve efficiency, reduce maintenance and cut power losses and copper investment. These changes may be made one step at a time.



SWITCHING

9. Check the capacity of your oil switches to handle your present and future loads, including those due to future interconnection with utility lines. Recently improved oil switches have greatly increased rupturing capacity for a given size switch. If you will need this some day, it may pay to install new switches now, or add these improvements to your present switches. An old and antiquated manual switchboard may justify a change to modern remote control to protect men, machines and reliability.

ELECTRIC SET PUMPS PITS

Replacing steam power, a portable 30-kw. electric generating set is saving Illinois Brick Co., Chicago, $20 a day in pumping clay pits. As plants have been shut down temporarily, to pump the pits dry it would be necessary to start up boilers, entailing a cost of from $50 to $60 a day, including initial warm-up period, labor and fuel. With this portable Westinghouse generator unit, it costs only about $30 a day. The generator is driven by a Hercules gasoline engine requiring about 100 gal. of gasoline and oil a day.

STOPPING WASTE IN
PUMPS AND COMPRESSORS

CHEAP WATER

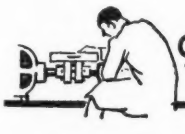
1. As boiler pressures go up and factory demands for service water increase, pumping economy and reliability become more important. When pumps must be selected for high-pressure boiler feed, the importance of correct application is generally realized and the best engineering service is secured. On the other side of the picture are thousands of badly engineered or run-down installations of feed pumps and service pumps. The modern trend is to look upon pumping as a distinct power service and to compute monthly the cost of water, including all pumping costs.

MAKE A PUMP SURVEY

2. General plans for power-plant modernization should always allow for a survey of pumping equipment. Each existing unit should be checked for reliability, efficiency, low maintenance cost. The job is not simple. It involves not only a lot of practical knowledge about pumps, but also some technical knowledge, because a good pump may operate smoothly and with low maintenance cost and still be a big money waster.

PUMP TOO LARGE?

3. The trouble, particularly with centrifugal pumps, is generally misapplication. A centrifugal pump, like a motor, generally has a low efficiency if operating load and pressure are far from those for which it was designed. A fairly close determination of actual efficiency can be made by comparing the horsepower output of the pump (computed from measurements of flow and head) with the power input of the driving motor. Where low efficiency is due to too large a pump, consider whether a new pump should be purchased or whether several pumps should be interchanged. Perhaps the motor is too large also.



CHECK SETTING OF PUMPS

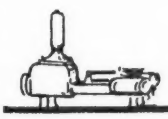
4. Where pumps vibrate and maintenance is high, check the setting. See that foundations are solid, pumps level and lined up with motors. See that suction pipe is large enough and free from unnecessary elbows. Make sure that suction lift is not too great for reliable and efficient operation. Make sure that hot-water pumps have adequate suction head.

NEW CENTRIFUGAL PUMPS?

5. Where none of these measures will insure reliable operation and adequate efficiency, compare results obtained with those obtainable with best units now on the market. Centrifugal pumps have been greatly improved in recent years. Get characteristic curves for the new units and figure possible savings. When installing new pumps, be very careful to get the right size, type and speed for the application. Consider the various types of self-priming devices available. Study materials used in the wearing parts, remembering that these will determine how quickly the efficiency will decrease with use.

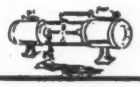
REMEMBER SPEED

6. Don't forget the question of speed. In all types of power machinery, higher speed means smaller units, less metal and generally lower first cost. Sometimes it means higher efficiency as well. Some of the new centrifugal pumps feeding boilers at pressures of 900 lb. and up operate at speeds up to 5,400 r.p.m. This reduces the number of stages needed. Both motor and pump are smaller and cost less. Correctly designed units will operate satisfactorily at high speeds. For many applications, a speed of 3,600 r.p.m. will be best.



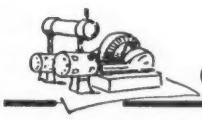
PLUNGER PUMPS

7. A piston or plunger pump may be highly efficient if mechanically driven through crankshaft and gears or belts. More commonly power-plant reciprocating pumps are direct-acting steam units. The very high steam consumption of these units may or may not be a source of expense. If the plant sends any steam to atmosphere or to condenser, these pumps are costly to operate, even if their exhausts are completely absorbed in open feed-water heaters. If electrically driven centrifugals are substituted, some of the main unit exhaust may be salvaged for feed heating.



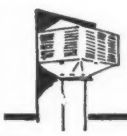
SLIP AND LEAKS

8. It is safe to say that slip and leaks in reciprocating pumps cause a national loss of many millions of dollars yearly. A general pump survey will reveal these losses and indicate whether it is best to correct them partly, by replacing parts and by better maintenance, or substitute new centrifugal units.



AIR COMPRESSORS

9. Many plants spend substantial sums for compressed air. Modernization plans should consider the possibility of increased use in the future. If present units are inefficient it may be best to install one or two efficient modern compressors, keeping the old units for standby service. Consider the greater efficiency of two-stage compressors and the desirability of driving them by synchronous motors to improve the power factor Automatic air unloading devices permit the compressor to turn over at synchronous speed, regardless of the load.



DIRT INSURANCE

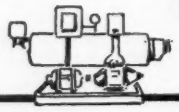
10. Any compressor worth keeping is worth protecting with intake air filters. They pay out quickly in reduced maintenance, longer life and maintained efficiency due to reduced wear of cylinders, pistons and rings.

MODERNIZATION CHECK SHEET

For your own modernization analysis, a check sheet is provided on page 620. It will assist you in making a survey of your plant and aid you in selecting those steps which offer greatest saving for least immediate investment.

PLANNED PROGRESS IN

HEATING AND REFRIGERATION

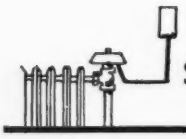


CONSIDER THE HEATING SYSTEM

1. Is the heating system in run-down condition? What could a good doctor do without killing the patient? Could a flock of leaking radiator traps, symbol of never-ending waste and trouble, be made well with new insides? Or would new traps be cheaper in the long run? Are the vacuum pumps on the job? Or would it pay to replace them or renew parts? How about installing packless valves to plug air leaks? Would it pay to salvage heat of returns in an "economizer"? Could heating costs be reduced by using orifices to balance the flow of steam.

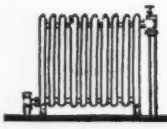
AND THE SYSTEMS

2. Is the present system not so good from the standpoint of economy and quality of service? If not, and if the plant may grow, it may be best to start now on a new system, rather than throw good money after bad. So, before renovating your present heating system, consider the advantages and disadvantages of all systems: steam, vapor, coil and fan, unit heaters, hot water. Perhaps forced-circulation hot-water heat direct from the condensers of low-vacuum prime-movers would work in nicely with your future heat balance?



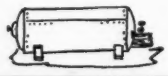
STEAM-SYSTEM CONTROL

3. Will your steam system operate under vacuum in mild weather? Why burn coal to overheat factory employees? Consider automatic thermostatic control of individual radiator valves or groups of valves. Rather costly, but saves a lot of coal. How about a zoned system to cut heating costs, with small investment?



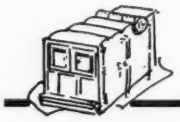
HOW ABOUT HEATING SURFACE?

4. Did the original installation provide just enough heating surface in each location? And rightly placed? Probably not. How about correcting these conditions to insure economical and comfortable heat? How about installing unit heaters for speedy heating up of large spaces? They can go in here and there at the start. Consider the indirect fan coils that are now, or might be, in your ventilating system.



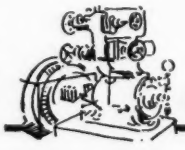
HOT-WATER HEAT

5. Are you now heating with hot water? Not enough heat, or bad distribution or slow warming up? If you run by gravity circulation, the installation of a circulating pump will probably cure these troubles. Or perhaps it would be better to change over to steam heat.



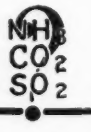
SOURCE OF HEAT

6. What's the heat source? Cast-iron heating boiler? Perhaps you'd do better with a regular power-plant, steel-tube boiler. The decision may hinge on future power generation. If district steam is available, compare its cost. Are you using live steam for heating and, at the same time, wasting engine exhaust to condenser or atmosphere? If so, switch and save.



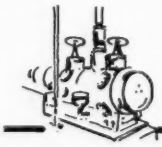
ALSO REFRIGERATION

7. Study your refrigerating system? Does it meet your present requirements economically? Will it take care of future requirements and fit nicely into an enlarged system with modern improvements.



WHAT KIND OF REFRIGERANT?

8. Are you using ammonia? Are any of the present and future applications such that ammonia leaks would lead to public danger or nuisance? Consider air conditioning in this connection. How about efficiency and first cost of equipment with the various refrigerants with your present and future temperatures and loads?

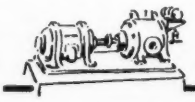


CAPACITY CONTROL PLUS EFFICIENCY

9. One key to refrigerating economy is high efficiency at widely varying loads. Consider pairing machines of widely different capacities so you can choose your horses to fit the size of the load of hay. Look into variable-speed drive as an efficient means of regulating machine output. Consider also adjustable clearance pockets on the cylinders for capacity control.

TWO SUCTION PRESSURES

10. You don't pump water thirty feet up to raise it ten. It is just as wasteful to operate the entire refrigerating plant at low suction pressure to supply low-temperature refrigeration for a small fraction of the load. It may pay to split suction pressures—low for very cold, higher for milder temperature. Consider operating different machines on different suction pressures, or using units with two different suction pressures.

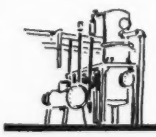


TWO-STAGE COMPRESSION

11. Consider also two-stage compression as another way to get low temperatures with better efficiency. At small cost you may add a booster compressor feeding the suction of your present machines. This will also permit lowering temperature of present system without replacing old compressors. Look into the new designs of booster units, including rotary boosters.

BETTER COOLING TOWERS

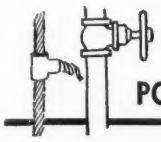
12. Look into the recent improvements in cooling towers: cooler exit water, less fan power, less spray loss. Perhaps a modern tower will pay now and fit also into any future system you may install.



STEAM-VACUUM REFRIGERATION

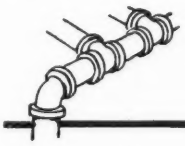
13. And steam vacuum refrigeration is again on the map. Several new systems and constantly increasing applications. Particularly adapted to modern temperatures required by air-conditioning. No moving parts. Consider it carefully with a view to future developments, but consider also steam consumption guarantees and the possibility of utilizing the exhaust heat in the plant heat balance.

BETTER ROADBEDS FOR
POWER IN MOTION



POWER ROADWAYS

1. In many old plants the power-service transmission system for electricity, steam, water, compressed air, refrigeration. etc., cries aloud for modernization. This may be undertaken one step at a time, along with, or separately from, the modernization of such power-equipment units as engines, turbines, boilers, etc. The importance of a plan is evident here. For example, if pipe lines are to be changed at all, the change should fit the future set-up.



HOW ABOUT PIPING?

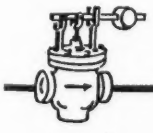
2. Some pipes are too small; some too large. The first requirement is that a pipe be large enough to insure the desired pressure at the outlet, and avoid undue fluctuations there (in the case of an engine, for example). A trunk line should be large enough for future loads. On the other hand, too large a pipe means waste investment in valves and insulation, as well as pipe.

Have adequate expansion joints been installed on the hot lines? They are a vital factor in leak prevention.

Good insulation on a bare hot pipe will pay out in three or four months. It should be a first step in modernization. Make sure that it is of ample thickness, well canvased and painted.

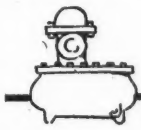
JOINTS AND VALVES?

3. Are the present pipe joints and valves reasonably tight, under existing pressures? Will the present joints, valves and piping stand up under the new pressure which may be adopted in a few years? If they will not, and it is necessary to make changes in piping to take care of the first modernization step, it might be well to put this part of the system in final shape.



REGULATORS

4. Regardless of any modernization of main power units, it is well to study the whole question of regulation, particularly reducing valves. If regulators now installed give poor service in pressure regulation, and are costing a lot for maintenance, they are a proper point of attack in one of the early modernization steps.



TRAPS

5. Some traps *are* traps. Others are just camouflage for steam waste. One prime essential of economical operation is constant inspection and maintenance of traps. And if maintenance and leaks run too high, it is a good investment to replace the old traps with serviceable units.

ROADS FOR KILOWATTS

6. In some ways electricity is easier to handle than steam or water. Yet electrical transmission has its problems. Are the conductors of ample size for present and future loads? Do they follow a short path to the load? If changes are necessary now, will it be better to design them as part of a better-arranged ultimate system?

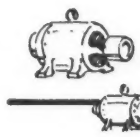
What is your present system power factor? What is reasonably obtainable? What would the difference be worth in dollars per year? How far is it worth while to improve power factor now by the use of synchronous motors, capacitors, better application of induction motors, etc?

MAXIMUM DEMAND

7. Most power rate schedules place a high penalty on abnormally high peak loads. A 15-min. peak on the thirtieth day of the month may cost hundreds of dollars. The prevention of such peaks is an operating problem, but recording wattmeters and automatic demand limitators are a tremendous help in preventing these occurrences. As a means of saving a lot of money with a moderate investment, these instruments may properly be one of the early modernization steps.

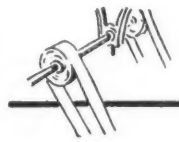
POWER APPLICATIONS

8. Power dollars are wasted in application as well as in generation and transmission. In fact, the application waste is sometimes the greatest of all. Motor applications are particular offenders. Check motor drives to see that right-size motors have been used. Over-loaded motors are bad and a source of maintenance expense. The loss from under-loaded motors, less obvious, may be even more important. Motors too large for the application are inefficient and have a bad effect on power factor. Inequalities can often be corrected by shifting motors around; changing motor sizes does not mean buying a new motor for each application.



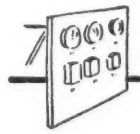
MOTORS

9. Replacement of slow-speed, direct-drive motors by high-speed belted or geared units (including gear motors) will generally reduce power consumption and improve power factor.



LINE SHAFTS AND BELTS

10. Check line shafts for alignment, friction, belt sizes, tension, efficient grouping, proper location of bearings. Avoid good money thrown after bad in extending a poorly laid out system.



METERS

11. Adequate meters are basic in any modernizing plan. That does not mean that every service must be metered at every step. Meters cost money. They should be put to work in places where they can earn their salt in savings. Meters in trunk lines, for example, in the main boiler-room steam outlet. Next come the main branches, such as steam to the engine room, and to two or three of the major factory departments.

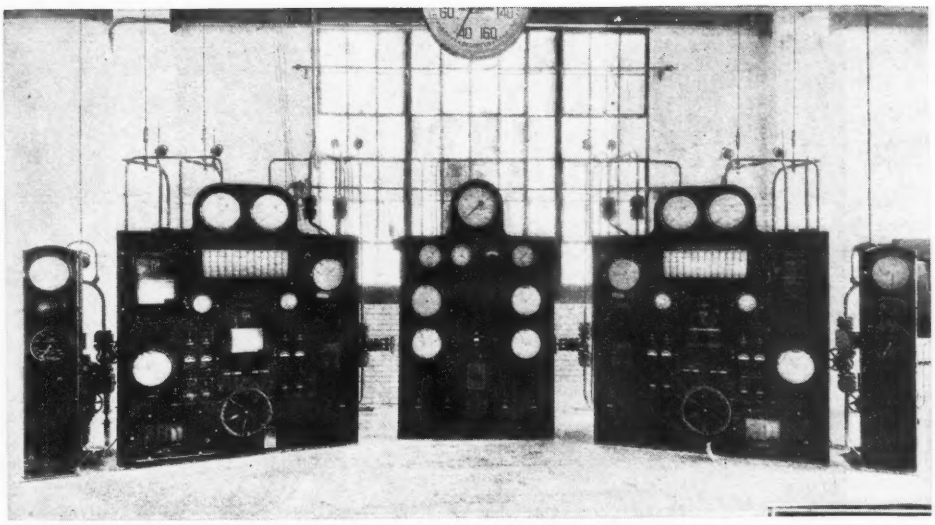
PLUS ACCOUNTING

12. Meter readings must be used to be of value. The first step in a meter modernizing plan is to set up a sound system of plant cost accounting, directly tied to the metering system.

MODERNIZATION PLAN CHECK SHEET

On this sheet may be summarized, for ready comparison and intelligent choice, the various proposed modernization steps. For further suggestions see preceeding articles. Details of modernization steps here summarized should be recorded in a permanent notebook

		Details on Notebook Page Below	Investment, Dollars	Yearly Saving, Dollars	Per Cent Return on Investment	Years to Pay Out	Fits Present and Future Power Plans	Fits Present and Future Heat Balance	Adapted to Present and Future Fuels	Maintenance O.K.	Reliability O.K.
		1	2	3	4	5	6	7	8	9	10
BOILER ROOM	Coal Handling and Storage										
	Oil Handling and Storage										
	Ash Handling										
	Boilers and Furnaces										
	Firing Equipment										
	Boiler Auxiliaries										
	Economizers and Air Heaters										
	Draft System										
	Feed Heating										
	Feed Treating										
	Feed Pumping										
	Blow Down										
	Meters and Instruments										
	Regulation and Control										
	Valves and Piping										
	Building										
	Miscellaneous										
ENGINE ROOM	Steam Engines										
	Steam Turbines										
	Diesel Engines										
	Gas Engines										
	Electrical Equipment										
	Auxiliaries										
	Meters and Instruments										
	Regulation and Control										
	Valves and Piping										
	Building										
	Miscellaneous										
MISCELLANEOUS SERVICES	Water Supply										
	Compressed Air										
	Refrigeration										
	Heating										
	Ventilation										
	Air Conditioning										
	Elevators										
	Miscellaneous										
SERVICE TRANSMISSION	Pipe Systems										
	Electrical Distribution										
	Mechanical Transmission										
	Meters and Instruments										
	Regulation and Control										
	Miscellaneous										
SERVICE APPLICATIONS	Process										
	Motors										
	Mechanical Drive										
	Miscellaneous										



Master and individual boiler instrument and control boards

Unusually flexible, this control system at Deepwater Plant of Houston Lighting & Power Co., Houston, Tex., provides for almost any combination of operations from manual to completely automatic control

AUTOMATIC CONTROL

. . . OPERATES 1,325-Lb. BOILERS

By EDWIN H. KRIEG*

Engineering Department,
Electric Bond & Share Company

DEEPWATER steam-electric generating station comprises two installations, one medium-pressure, the other high-pressure. The former has 135,000 kw. of generating capacity operating at 350 lb. pressure. The latter, which is a new section of the plant, includes a 12,000-kw turbine-generator that operates at 1,290 lb., and two B. & W. cross-drum, single-pass boilers, with superheaters, steaming economizers, tubular air heaters and side and down-take water walls. These boilers have a maximum steaming capacity of 350,000 lb. per hr. each, with a steam temperature at the superheater outlet of 840 deg. F. at 1,325 lb. pressure.

Boilers are normally fired with natural gas, burned in 20 combination oil and gas burners, arranged in two horizontal rows in the down-take water wall, the combustion process being automatically controlled by a Bailey Meter Company system. Should the gas supply fail a change to oil firing can be made in a few minutes.

An 8-in. valve in the gas line to each boiler regulates fuel supply to its furnace. This valve has a maximum capacity of 5,900 c.f.m. of gas at 8 lb. gage. Inlet gas pressure may vary from 12 to 24 lb. gage and outlet pressure from 1 to 8 lb. The valves have practically a straight-line flow characteristic, so that equal increments of valve-stem travel will cause equal changes in gas flow. Inlet pressure being higher than outlet pressure, the inlet has an 8-in., and the outlet a 12-in., flange connection. These valves can be controlled automatically or manually. Handwheels for manually controlling gas valves are on the individual boiler-instrument boards on either side of the master boiler-instrument panel.

Each boiler is equipped with two double-inlet, single-outlet induced-draft fans driven by 2-speed, 600- and 150-hp., squirrel-cage induction motors. Fan inlets are connected to the air heater through two inlet boxes, in each of which is an isolating damper connected to a Carrick motor-actuated operator.

These fans each have four inlet vanes, controlled by the automatic combustion-control system. Each vane is operated as a separate damper through a linkage, the dampers opening or closing consecutively. A single discharge duct, having a 2-leaf, hand-operated damper, connects each fan to the stack breeching.

The first 20 per cent of opening travel of the induced-draft-fan inlet vanes gives a large change in rate of gas flow; during the remainder of opening travel, rapidly diminishing increments of flow occur. Cams are used on the damper shafts to compensate for this condition and produce approximately a straight-line relation between flue-gas flow and control-lever movement.

There are also two double-inlet, single-outlet, forced draft fans per boiler, driven by a 2-speed, 200- and 50-hp., squirrel-cage induction motor. These fans take their suction from either the fan room, the upper portion of the boiler room or from the air-cooled furnace floor, or any combination of these. Each fan has a 2-leaf damper in its discharge housing operated by the automatic combustion-control system. In series with this damper is a 3-leaf isolating damper controlled by a motor-actuated Carrick operator.

Ducts from the fans join in a common breeching on the air-heater inlet. The air-heater discharge duct splits

*Now with the American Gas & Electric Company, New York City.

and goes to each side of the boiler. Each of these ducts has a manually operated 2-leaf damper.

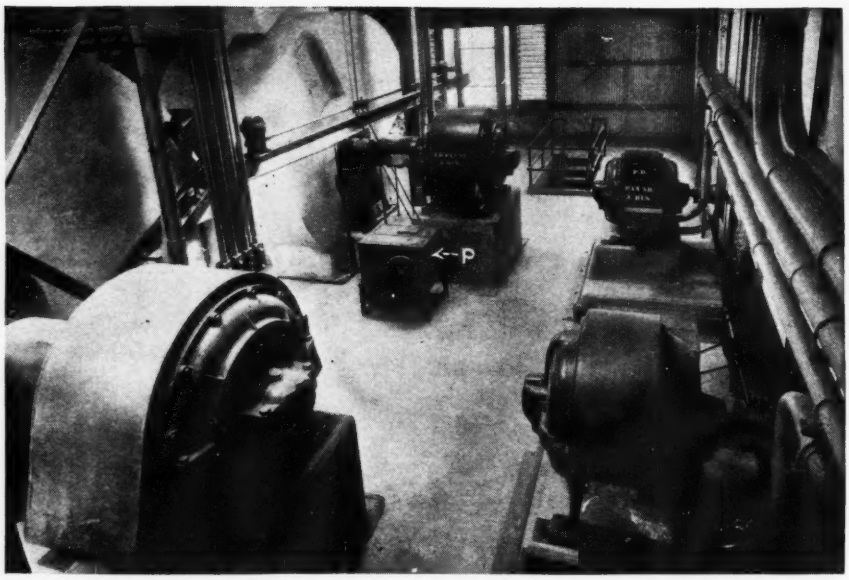
Combustion is regulated according to the rate of change in steam pressure, using instantaneous pressure as a secondary modifying control. A master steam-pressure contactor connects to the steam main and regulates fuel and air supply to the furnaces in proportion to steam demand on the boilers.

To supply air required to burn gas with minimum loss, it is necessary to:

1. Maintain furnace draft at minus 0.1 to 0.15 in. static water gage at all outputs.

2. Control draft in proportion to fuel to maintain a constant or a desired variable per cent of excess air (or CO_2) at the economizer inlet.

This is done by power units that automatically manipulate the forced- and induced-draft fan motors, the induced-draft fan inlet vanes and forced-draft fan discharge dampers. These power units have a pair of normal-speed clutches that respond to electrical impulses from the master steam-pressure contactor, the steam-flow air-flow contactor or the hand-operated push buttons. Readjustments of the induced draft are made according to the steam-flow air-flow relation of the boiler meter on each boiler so that any desired fuel-air ratio can be obtained. The forced-draft fan discharge dampers are automatically readjusted to maintain constant or variable furnace draft.



Fan room, showing forced- and induced-draft fans on one boiler. Power unit for induced-draft fans can be seen at *P*.

Readjustment of fuel-air ratio and furnace draft is made by a contactor mounted in standard Bailey boiler meters. These meters are equipped with a hand-operated device to compensate air flow for feedwater temperaturs over a range of 250 to 375 deg. F., normal temperature being 350 deg. F.

The use of 2-speed fan motors in combination with inlet-vane control requires precautions when fan speed is changed. When it is necessary to increase the speed of induced- or forced-draft fans, the power unit energizes the speed-changing circuits of the motors. When the motor starts to accelerate, a high-speed reset mechanism is energized and begins closing the induced-draft-fan inlet vanes and forced-draft fan discharge dampers. This action counteracts the effect of increasing motor speed, so that the fan output, immediately after the speed change, is practically the same as at the lower speed. The reverse of this operation occurs for a reduction in motor speed. The points of transition overlap to prevent repeated changing of motor speed when the fans operate near these points.

Time-delay relays are connected into the control circuits so that low-speed windings on fan motors will be energized only after they have decelerated for a period approximately equal to that of acceleration. It was not found necessary to connect reactors in series with the high-speed windings of the motors when going from low to high speed.

There is one power unit for each group of two induced-draft fans and one for each group of two forced-draft fans per boiler. At times, only one forced- and one induced-draft fan may be in service on one boiler. To make it unnecessary to disconnect the automatic control from the fans not in service, as previously meitioned, two sets of dampers are provided, one operated by the automatic combustion control system and the other for isolating the fan when it is shut down. The motor-actuated operators on the isolating dampers are interlocked with the fan-motor controls to close these dampers automatically if the fan motor stops.

Safety features are provided to prevent damage to combustion-control equipment and to prevent dangerous operating conditions. Inter-locks between fuel and air controls prevent reducting the air when fuel control is in minimum position and prevent an increase of fuel when the air control is in its maximum position. An annunciator drop on the master boiler-instrument board indicates when air supply is at maximum, and that no more fuel can be supplied. In each power unit, a slip-clutch prevents the 0.5-hp. motor from burning out in case something stalls the equipment. The power units also have limit cams to prevent over-travel.

Interlocks also insure proper operating sequence of the equipment. These interlocks perform as follows:

1. Either induced draft fan can be initially started manually from its start-stop pushbuttons on the individual boiler-instrument board or at fans. Initial starting is done with the low-speed circuit breaker in closed position.

2. Neither forced-draft fan can be started unless one of the two induced-draft fans is running, but if one induced-draft fan is running, both forced-draft fans may be operated.

3. When the induced-draft fans stop, the forced-draft fans on the boiler automatically stop also.

4. When the forced-draft fans stop, the fuel-gas valve on that boiler automatically closes, although the induced-draft fans will continue to run. The fuel-gas valve cannot be opened unless at least one forced-draft and one induced-draft fans are running.

5. When a fan stops its motor-operated isolating damper closes and automatically prevents recirculation from the other fan. The damper cannot be opened again unless the fan motor is running. This prevents

furnace disturbance and a possible boiler shut-down due to recirculation from the other fan in operation.

Provision has been made for placing any portion of the combustion-control system under pushbutton manual control, including the motor-operated dampers, from the control panels.

By turning a knob on the master boiler-instrument board, the operator can change from full-automatic control by steam pressure to pushbutton control. The steam pressure can then be varied at will while fuel-air ratio and furnace draft are still automatically maintained. Switches on the individual boiler-instrument boards permit the following departures from full-automatic control:

A. Air and fuel controlled by push-button, with induced draft adjusted automatically, according to steam-flow air-flow, and forced draft according to furnace draft.

B. Induced draft controlled by pushbutton and forced draft adjusted automatically according to furnace draft.

C. Fuel controlled by pushbutton.

D. Forced draft regulated by pushbutton.

E. Induced draft adjusted by pushbutton.

Thus, complete pushbutton control of any factor can be had through the individual boiler switch, and independent of the master contactor.

When it is necessary to burn oil, the combustion control will automatically regulate the excess air and furnace draft according to the oil supplied by hand. The oil may also be regulated automatically, using the gas-valve power unit. Full-automatic control for oil required installing oil regulating valves only and a linkage to connect them to the gas-valve power units.

The automatic combustion-control system maintains steam pressure within one per cent, or 13.25 lb., above or below 1,325 lb. when operating conditions are normal and a maximum variation of 2 per cent plus or minus for abnormal conditions. Although there may be a maximum variation of 5 per cent excess air from the desired value, the average is only about 3 per cent or less under normal operating conditions. These figures hold for any feed-water temperature, provided adjustment is made on the compensator in the Bailey boiler meter.

The automatic combustion control system operates successfully over a load range from the maximum output down to 25 per cent of that capacity. Over this range the combustion efficiency is held at practically test value and furnace-draft conditions are maintained that give the most economical operation.

Steam-flow air-flow contactors can be adjusted to maintain a constant total air at all ratings or a graduated total air, changing with rating according to a predetermined relation. If conditions in one boiler differ from those in the other, the contactors may be adjusted to maintain the fuel-air ratio of each boiler at the value best suited to it.

Furnace draft can be maintained at a constant or varying value.

By means of the individual boiler-control switches, one boiler may be operated on base load and the other take the swings with automatic control. A difference in output may be established between the two boilers and this difference maintained automatically at all outputs.

The entire installation has been so designed that pulverized coal or other fuels can be burned in the future if this should prove desirable. If additional boilers are installed no additional master-control equipment will be needed, individual boiler-control equipment only will be required.

The equipment has given successful service and has met expectations in reduced operating costs, and increased safety and reliability.

Theoretically, it is possible to operate steam-generating units manually at their best efficiency at all required loadings. Several operating companies report doing so. It is a large order, however, to hold constant steam pressure by hand operation and maintain correct fuel-air ratio at all outputs. In any event, for manual operation, pushbutton control is needed at a central location in large boiler plants, together with interlocks on the various pieces of equipment to insure their being operated in proper sequence. If the cost of pushbutton control and safety devices is credited to that for full automatic combustion control, it will be found that only a slight increase in the yearly boiler-room efficiency is needed to make profitable the additional investment for the latter.

Deepwater steam-electric station was designed by the engineering department of Electric Bond & Share Company, New York City, for the Houston Lighting & Power Company, Houston, Texas, with the cooperation of the engineers of the latter company.

PUMPING STATION MOTORS TO SET EFFICIENCY RECORD

THE six 1,500-hp. Westinghouse synchronous motors for driving centrifugal pumps at Chicago's new Harrison Street station will set a record in efficiency for machines of that size. An ingenious design makes possible across-the-line starting with less than 400 per cent current inrush. Because operation is continuous, over-all efficiency of the motors and their exciters has been made high, at least 97.9 per cent, an efficiency comparable to that of motors rating 25,000 hp.

The active iron used in these motors will be specially selected and tested for low losses, thus allowing best proportioning of material in the machine. The amount of active material is much greater than in machines of normal efficiency. Liberal use of copper and iron to keep flux and current densities low and proper proportioning of parts combine to make the high efficiency possible.

The conventional method of starting large high-speed motors for pump drive is by use of a transformer or reactor to reduce motor voltage temporarily. This will be replaced by connecting the motor through circuit breakers directly to full-line voltage. Starting current will be limited by the electrical design of the motors.

Saving Money With Alloys—Increasing oil pump piston-ring life from six weeks to thirteen months by a change of material, one American oil refiner has saved 1,300 gal. of lubricating oil, in addition to savings in labor and outage time. He substituted nickel-chromium cast-iron rings for cast-iron. Other new materials include copper-nickel alloy condenser tubes in six new U. S. destroyers. They will have the following blading in their turbines: impulse blading for the first two rows of short blades, stainless steel; major bank of longer blades, monel metal; low-pressure blades, Naval brass (70 per cent copper, 30 per cent zinc).

GET THE MOST OUT OF YOUR

Not all gland troubles are due to the type of packing used. Here are some of the things to look out for before blaming the packing

HOW can I get the best service from my pump or engine rod packing? This is a question that probably the chief engineer of every plant, large or small, has at some time put to himself. The general answer is two-fold and simple, though not always easy to accomplish. First, he must secure the packing best suited to the particular conditions in which it is to operate. Second, having the proper packing, it must be installed with care and in such a manner as will give longest life with minimum friction and shaft wear. Both are equally important, for the best packing will not give the service built into it if carelessly or improperly installed.

It is not fair to expect packing to be a cure-all, for it can not make up for mechanical troubles in the equipment being packed. When packing troubles are suddenly encountered, it is better first to look for mechanical troubles than to assume the quality of packing has changed and start experimenting with the numerous types and brands available.

What are some of these mechanical conditions that spoil good packing? Badly scored, irregular and crooked rods or shafts is a mechanical condition common to all types of packed machinery that make tight and long-lived packing difficult or impossible depending upon the degree of wear.

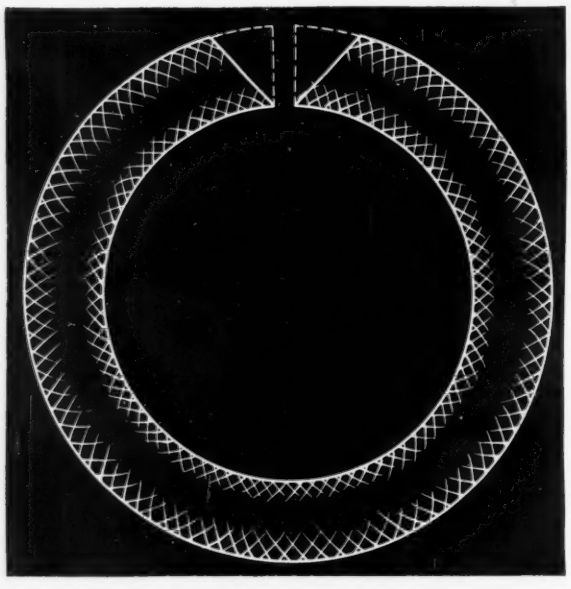
Scored rods obviously cause excessive packing, wear and consequent short life. Packing around reciprocating rods that have an appreciable variation in diameter will in general not remain tight for long. Ordinary packing under such conditions quickly assumes the larger shaft diameter. Leaks soon result, making necessary frequent taking up on the gland. The packing is thus soon compressed and hardened, its resilience is lost and it must be renewed. There are packings of special shape designed for this condition, but even these have a limit in the variation of rod diameter that can be compensated for. Such packings are very valuable in that they may put off indefinitely the day when the expensive job of replacing or refinishing the rod must be undertaken.

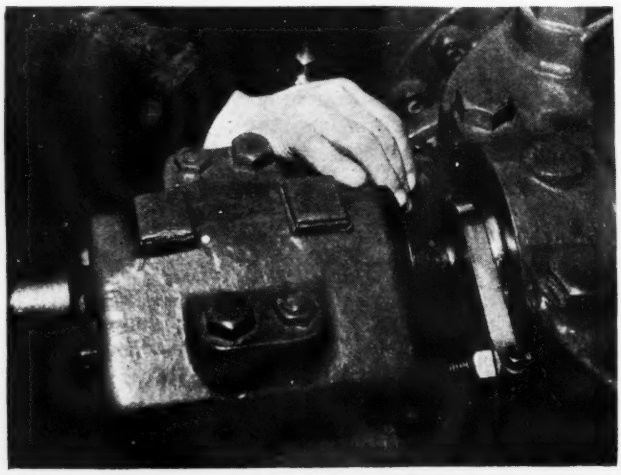
A rod operating out of parallel with the cylinder is another source of packing trouble. On engines and pumps with crossheads this condition is easily remedied by proper adjustment of the cross head, and should be corrected as soon as possible. A vibrating shaft in centrifugal pumps causes similar trouble, but is not so easy to remedy.

Occasionally, packing seems to disappear from the gland. Don't immediately blame the packing, but inspect the clearance between the rod or shaft and the cylinder at the throat of the stuffing box. This may have increased to such extent that the packing is pushed through into the cylinder. Such a condition is easily remedied by installing a ring in the bottom of the gland machined to fit the shaft with normal clearance. Many packing manufacturers stock such rings, or will make them when proper data is given.

Many of the mechanical conditions causing these packing troubles have paradoxically been caused by the packing itself, because of wrong packing, poor installation, or attempts to economize by making worn-out packing "last a little bit longer." Packing should be replaced before it is necessary to pull up hard on the gland nuts to stop excessive leakage. When packing has reached this condition, the lubricant is mostly gone, the packing is hard, and a scored shaft or rod will be the likely result of its continued use. Power loss due to increased friction and the danger of scored shafts makes this type of packing economy a false economy. The same danger of damage to shaft or rod exists if excessive gland leakage is allowed to continue long. Repack before it is too late!

Packing should be cut as shown by the dotted lines, not as shown by the full lines





Gland nuts should be no more than finger tight on new packing

PACKING

By R. B. PURDY
Associate Editor, POWER

The first step in repacking a stuffing box is to remove all of the old packing. Various hooks and augers are available for this none-to-easy job, particularly if the packing has become hard. However, the box should be thoroughly cleaned before putting in fresh packing.

Particular care should be exercised in cutting the first packing ring so that it can be used as a template for preparing the remaining rings. Whenever the type of packing permits, the ring ends should be scarfed or beveled. Some packing, however, if cut in this manner, will unravel and so should be cut square and the ends butted together. Whether the joint is beveled or butted, the ends of the ring should be cut so that when formed around the shaft they are parallel to each other. The diagram illustrates the condition to be avoided.

Keep in mind that certain types of packing swell after installation due to the action of the fluid being sealed. For this reason, the rings are cut from a $\frac{1}{16}$ to $\frac{3}{16}$ in. short, depending upon the diameter of the shaft being packed. Care should be taken to cut all rings as nearly alike as possible so all rings will be equally tight on the shaft. When flax or tucks packing is used it should be soaked over night in water before installing it, so that it will swell. Should urgent demand for the pump make this impossible, the packing should be put in loosely to allow for swelling.

If the packing is the proper size for the gland, the rings should slide easily into the stuffing box. Plenty of lubricant such as oil or grease and graphite will help in working packing in. If the packing is of special shape, be sure the rings are put in the gland right side up. Each ring as it is put in should be seated thoroughly and evenly against the previous ring. The joints must, of course, be staggered so as to cause as little leakage through them as possible. When metallic packing is used, it should be formed to the shaft with a mallet or piece of wood before inserting in the gland.

In breaking the joints, the first ring put in should have its joint on top of the shaft. The next joint should be placed 90 deg. from the first. No joints should be placed at the bottom of the shaft.

In pump stuffing boxes that are provided with lantern glands, care must be taken to insert the right number of rings ahead of the lantern so it will be in proper position to receive sealing water after taking up the packing.

Probably more good packing is spoiled by tightening the gland follower too much than in any other way. If the rings have been properly put in and seated, the follower should bear evenly on the last ring and be parallel and concentric with the shaft. Take up evenly on the gland with a wrench to insure proper seating of the rings and then back off the nuts. The nuts should then be brought up only *finger tight*. For this reason care should be taken not to injure the threads on the gland studs, making a wrench necessary to turn the nuts. Don't tighten up on the gland to stop leakage when the machine is first started. A freshly packed gland should be allowed to leak somewhat excessively until the new packing has had a chance to work in. Remember that with water, new packing tends to swell and with hot water it may be necessary, due to expansion, to back off on the gland nuts. With water, the gland should not be so tight that no leakage occurs—a small leak not only acts as a lubricant but also keeps the packing cool. On refrigerant compressors and the like the gland must of course be tight from the start, consequently frequent readjustment of the gland is necessary until the packing has worked in.

It is difficult to generalize with respect to the selection of packing, as so many variables enter the problem. Packing lubrication is of utmost importance, and different lubricants are required for various fluids and temperature conditions. The lubricant should be such that it will not be carried away by the fluid sealed or melted out of the packing by the temperature.

Packing made from cotton or other vegetable fiber can not be expected to stand up under conditions of high temperature. Cotton fibre disintegrates at about 300 deg. F. Where mineral lubricating oil is the fluid being sealed, the packing should not contain rubber unless it has been specially treated to withstand the disintegrating action of oil. On the other hand, much economy in packing can be secured in large plants by carefully standardizing on relatively few types, thus permitting reduction in the amount of packing kept in stock.

PIPING WATER TO LOS ANGELES

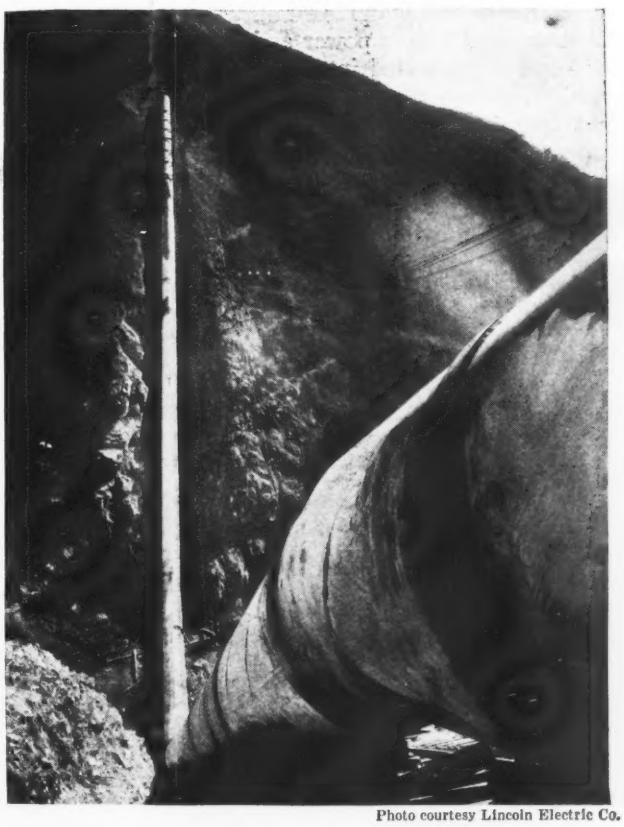
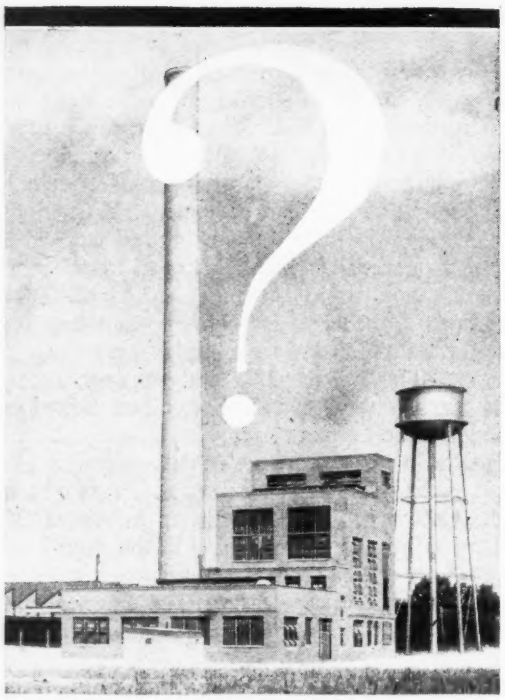


Photo courtesy Lincoln Electric Co.

Largest in the West, this 4½-mi. arc-welded pipeline will soon join Bouquet Canyon Reservoir with Owens Valley Aqueduct, part of Los Angeles' water supply. It varies from 7 ft. 10 in. to 6 ft. 8 in. in diameter with pipe $1\frac{1}{16}$ in. thick at the smallest-diameter sections where pressure is greatest. The 12-ton sections are placed on mountainside by hoist



ALL POWER SERVICES PROVIDED BY MYSTERY PLANT

By R. S. FITCH
Mechanical Engineer,
The Ballinger Co.

On a reduced scale, building of industrial power plants has continued right through the depression. Here's another, name deleted at its owner's request. Features: 400-lb. steam pressure, by-product power generation, dual-drive auxiliaries

RELIABILITY was the principal factor controlling plant design and selection of equipment for the simple and efficient layout of the —*Corporation power plant. High- and low-pressure steam, electricity, refrigeration and compressed air are all supplied by this plant as required for power and process.

Steam is generated in two 3,960-sq.ft. (heating surface) bent-tube boilers, fired by multiple-retort stokers and operating at 400 lb. gage pressure and 100 deg. superheat. Byproduct power is generated by two 937-kva. non-condensing turbine-generators, delivering 440-volt, 3-phase, 60-cycle current. Plant heat balance is obtained by utilizing intermediate pressure steam-driven and electrically driven ammonia compressors. Seasonal control of the heat balance may also be obtained by changing auxiliary drives, for all essential auxiliaries are provided with dual drives.

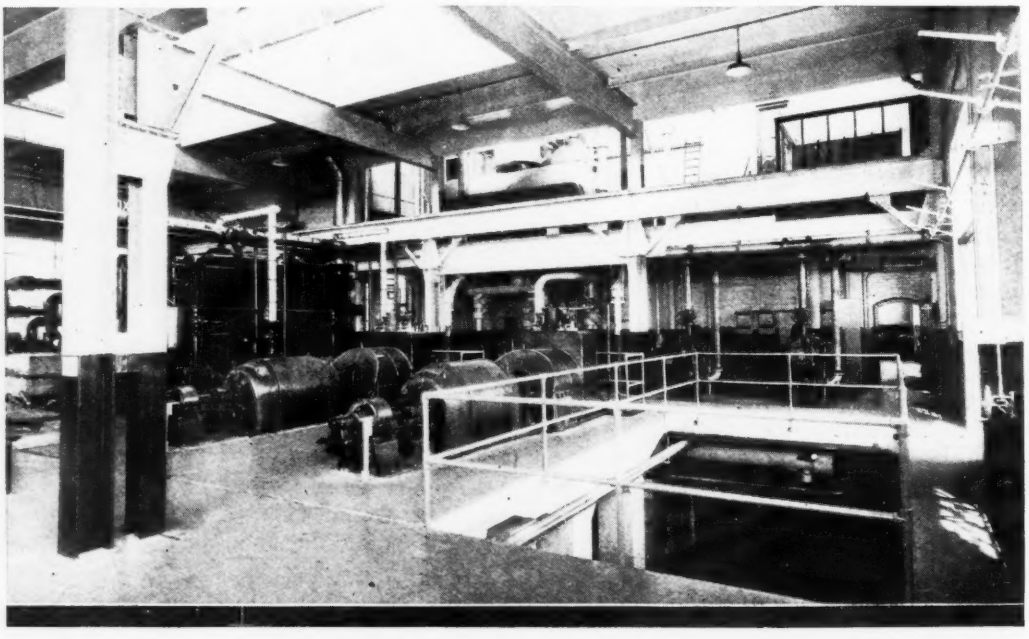
The two turbo-generators are provided with direct-connected exciters. Standby excitation is furnished by a 25-kw. dual-drive exciter set. Generator air is cooled by U-fin coolers.

The major part of the electrical demand is generated by these turbines, a small part being purchased from a power company by means of a parallel connection from a 1,000-kva. transformer bank. This standby connection is such that if for any reason the generated load is dropped, the outside lines pick up the load and assure constant service.

Exhaust steam at 60 lb. pressure, supplemented by steam from the boilers through reducing valves, supplies process requirements.

Boiler feed pumps and air compressors are located

*Permission to publish this article was granted only upon the condition that the owner's name, business and location be not given.



Turbine room, showing the two non-condensing 750-kw., 3,600-r.p.m. turbines, air compressors and refrigerating equipment

between the boiler and turbine room, while the feed-water heater and engineer's office are on a gallery above.

All meters and indicating gages are on a central panel in the engineer's office to insure constant supervision of operating conditions. The main control switchboard is in the turbine room, but the switch structure is directly below in the basement. The turbine room is a one-story structure with a basement connected to the manufacturing plant by a tunnel carrying all utilities. Refrigerating apparatus is also provided in the turbine-room section of the power house.

The boiler room, shown below, houses the two boilers on the "second-floor" level, while the ash-handling apparatus is at grade. This general arrangement of the plant provides a maximum of light and air to the major portion of the building and equipment.

Boiler settings are constructed of special refractories utilizing air-cooled walls. After trial operation, water cooling was added along the "clinker line" and at the bridge wall to prevent clinkering and slagging at peak ratings. In addition, air heaters deliver preheated air to the stokers at 300 deg. F.

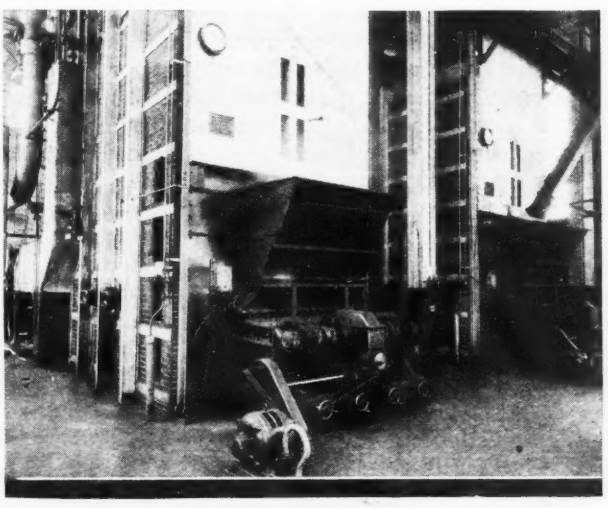
Four-retort stokers, underfeed type, fire the boilers, delivering 25,000 lb. of steam continually, burning coal of 14,000 B.t.u. per lb. heating value. The stokers are driven by variable-speed motors.

Each boiler is provided with a forced- and an induced-draft fan so that the boilers may be operated as independent units or in parallel. Forced-draft fans are provided with variable-speed motor and steam turbine drives, and the induced-draft fans with constant-speed motor and steam turbine drives. Fans, stokers and dampers are controlled by the Gray system of automatic combustion control, with the master control from the steam pressure.

Returns from the plant are stored in a hotwell in the turbine room basement and handled by booster pumps to an auxiliary storage tank at the top of the boiler room. Feed water flows by gravity from this tank to the deaerating feed-water heater operating at 6- to 8-lb. pressure. Makeup water is automatically introduced through a zeolite softening system of the hotwell. Sodium phosphate is also used to maintain the proper carbonate-sulphate ratio in the boilers.

Motor- and steam-turbine driven, multi-stage, centrifugal boiler-feed pumps, provided with pressure regulators, deliver water to the boilers.

Two 3,960-sq.ft. boilers provide steam at 400 lb. pressure



Constant supervision of proper heat balance conditions is obtained by the use of recording and indicating instruments at all strategic points. Walkways and stairs of steel grating provide access to all parts of the boiler and steam header and to the coal-storage bunkers.

Both the power plant and the industrial plant which it serves were designed and supervised by The Ballinger Company, in conjunction with the company engineers.

PRINCIPAL EQUIPMENT OF POWER PLANT

Boilers, Stokers and Accessories

Boilers—Two, bent-tube type, 3,960-sq.ft., minimum continuous 33,500 lb. per hr., maximum 38,000, steam pressure 410 lb. ..... Combustion Engrg. Co.
Superheaters—Two "Elesco" 100 deg. F. at 200% rating ..... Combustion Engrg. Co.
Stokers—Two 4-retort, 92.45 sq.ft. projected area, with variable-speed motor drive .... Combustion Engrg. Co.
Clinker Grinders — Motor-driven, constant-speed ..... Combustion Engrg. Co.
Air Heaters—Two vertical-tube, counter-flow, 2,260-sq.ft. ..... Combustion Engrg. Co.
Refractories—Air-cooled walls ..... American Arch Co.
Water-cooled walls ..... Combustion Engrg. Co.
Boiler Setting ..... J. R. Fisher Co.
Water Columns ..... Reliance Gauge Column Co.
Soot Blowers ..... Vulcan Soot Blower Co.
Feed-Water Regulators, Copes ..... Northern Equipment Co.
Combustion Control—Gray system steam pressure gages ..... Consolidated Ashcroft-Hancock Co.
Draft Gages ..... Ellison Draft Gage Co.
Flow Meters, Temperature and Pressure Recorders ..... Brown Instrument Co.
CO_2 Recorders ..... Hays Corp.

Coal Handling

Track hopper—24-in. x 35-ft. inclined apron conveyor, single-roll crusher, vertical continuous bucket elevator (94-ft. centers), horizontal distributing flight conveyor (42½-ft. centers), five bunker gates, 2,000-lb. capacity hand-propelled traveling weigh larry and four industrial ash cars ..... Link-Belt Co.
Ash Gates—Ratchet operated, water cooled, dumping to ash cars on track ..... Allen-Sherman-Hoff Co.

Draft Equipment

Duct work ..... Connery & Co.
Chimney ..... M. W. Kellogg Co.
Forced-draft Fans—Two super-turbo, capacity (each) 21,300 c.f.m. at 150 deg., 7.04 in. static pressure, dual drive—40-hp. G.E. slip-ring motor and G.E. steam turbine ..... Buffalo Forge Co.
Induced-draft Fans—Two double-duplex, capacity (each) 33,500 c.f.m. at 350 deg., 4.75 in. static pressure, dual drive—40-hp. G.E. squirrel-cage motors and 50-hp. G.E. steam turbine ..... Buffalo Forge Co.

Water Treatment

Permutit softeners, 8,500 g.p. hr. ..... Permutit Co.

Feed-Water Heater

Capacity, 2,400 hp. deaerating heater unit, 2,894 gal. horizontal steel storage tank, 15 lb. working pressure ..... Eliott Co.

Pumps

Boiler Feed—One 2-in. 4-stage centrifugal, 144 g.p.m., 1056 ft. discharge head, driven by 90-hp. G.E. steam turbine, 2,600 r.p.m. One 2-in. 7-stage, centrifugal, same capacity, driven by 100-hp. G.E. squirrel-cage motor, 1750 r.p.m. ..... Warren Steam Pump Co.
Booster—Two 3-in. single-stage, centrifugal, 320-g.p.m., 105-ft. discharge head, driven by 15-hp. G.E. motors at 1,750 r.p.m..... Warren Steam Pump Co.

Turbine-Generators and Auxiliaries

Turbines—Two, non-condensing, 750-kw., 3,600-r.p.m. with 400-lb., 100 deg. superheat steam at 60-lb. gage back pressure ..... Westinghouse Electric & Mfg. Co.
Generators—Two 937-kva., 480-volt, 0.8 P.F., 3-phase, 60-cycle ..... Westinghouse Electric & Mfg. Co.
Exciters—Two direct-connected, 15-kw., 125-volt, D.C. ..... Westinghouse Electric & Mfg. Co.
Standby Exciter—One 25-kw., 125-volt, D.C., dual-drive ..... Westinghouse Electric & Mfg. Co.
Generator Air Coolers—U-fin type ..... Griscom-Russell Co.

Electrical Equipment

Switchboard—12-panel main board and 440-volt switch structure ..... Westinghouse Electric & Mfg. Co.
Transformers—1,000 kva. bank, public service connection.

Miscellaneous Equipment

Piping ..... M. W. Kellogg Co.
Valves ..... Lunkenheimer Co.
Pipe & Fittings ..... Stockham Pipe & Fittings Co.
Back-pressure Valves ..... Cochrane Corp.
Blow-off Valves ..... Yarnall-Waring Co.
Pressure Reducing & Regulating Valves.... Atwood & Morrill Co.
Relief on 60-lb. system ..... Atwood & Morrill Co.
Safety Valve ..... Consolidated Ashcroft-Hancock Co.
Steam Traps & Separators ..... Cochrane Corp.
Drawings, Specifications, Supervision ..... The Ballinger Co.

COAL-HANDLING EQUIPMENT

FOR SMALL BOILER PLANTS

By H. V. SCHIEFER
Engineering Department,
The C. O. Bartlett & Snow Company

Here's how to engineer an economical coal-handling system for a small boiler plant and the types of equipment available for doing the job

SMALL boiler-house design involves problems similar to those found in central station and large industrial plants, except on a smaller scale. Frequently, proper attention is not given to the location of small boiler houses for convenient handling of coal and ashes. Steam and water can be piped, but coal and ashes must be handled mechanically.

Coal-car traffic is too often neglected when a boiler-house site is selected. If three cars of coal per day are to be burned, then the coal switch track should have tail-room for placing at least two empty cars (when cars can be switched once a day only). Dead-end tracks with one-car capacity are too often contemplated and sometimes installed. Why install coal-unloading machinery for 50 tons per hour when the maximum that can be delivered to it is 25 tons?

Practically all modern boilers are either stoker or pulverized-coal fired. Stoker magazines and pulverizer hoppers are too high to permit shoveling coal, therefore, regardless of economy, mechanical coal-handling equipment is required.

Endless varieties and types of coal-handling machinery are available, and, unfortunately, there are many grades of each kind. A simple, reliable, well-designed system usually costs no more than a complicated haphazard one, even when first cost is considered.

Formerly, the usual coal-handling system consisted of many conveyors with chains and motor drives. The firing aisle was a dark, cluttered-up place with a continuous overhead bunker and a forest of coal spouts leading to the stoker hoppers.

In a modern small plant, coal-handling machinery is frequently independent of the boiler-house building. It is practically automatic in operation and usually has only one motor drive and that placed near ground level where it can be easily inspected and oiled. Such a system may comprise a track hopper, a skip hoist, an overhead bunker and a weigh larry. It can be bought completely erected for from $6,000 to $15,000, depending on boiler-house size, amount of overhead storage and length of larry runway.

Rate of handling coal should be from 20 to 50 tons per hour, so that one man can bring in the day's supply in a half day, allowing the other half for removing ashes and cleaning up.

Track hoppers should be of generous size, not less than 10 × 10 ft., but 12-ft. dimensions are better. For the capacities in question, a larger hopper serves no particular advantage and requires a deeper pit.

Fig. 1—Skip-hoist for coal handling to a small boiler plant

Several years ago it was not easy to get a continuous supply of slack coal, and it was therefore necessary to install a crusher, but that is not generally true today. A crusher for reducing run-of-mine coal to 1¼-in. size is quite a machine. It requires a feeder and about a 20-hp. motor, and if placed under the track hopper requires a pit about 6 ft. deeper than when the crusher is omitted.

It is not a difficult job to break some lumps by hand if a few cars of run-of-mine coal, which averages about 40 per cent slack, must be used. A steel grillage over the track hopper can be bought for less than $200. Assuming that it may cost 20 cents a ton for extra labor to break lumps by hand on the grillage, it would take a long period of hand crushing to warrant an expenditure of around $2,000 for a crusher with its feeder, bypass and foundations. In the Middle West, records of various boiler houses show that practically no run-of-mine coal has been bought since the World War.

Fully automatic skip hoists have been developed until they are very reliable elevating machines, having low first cost. A record of four skip-hoist installations total-

ling 30 skip-hoist years shows an average repair cost of $35 per year per hoist.

A fully-automatic skip hoist consists of an automatic gate, a bucket, a cable, a steel tower and a hoisting machine. When there is coal in the track hopper, the hoist starts operating automatically and continues to run until the hopper is empty or the overhead bin is full.

The hoist bucket is a simple steel box on wheels. The wheels are chilled iron and run on tee rails. The rails will last as long as the boiler house and the wheels for many years. With properly designed sheaves, the cable will have several years' life. If a cable is periodically inspected, there is no excuse for a failure.

Since boilers run continuously and coal is unloaded, say, during four hours per day, overhead storage is essential. Years ago when conditions were different, it was considered necessary to have as much coal as possible stored in overhead bunkers. In extreme cases, a supply for a week or more held in reserve and made the boiler house appear to be a coal-storage plant with a few boilers placed underneath. The result was a dark, unventilated, expensive boiler plant.

With present regularity of coal shipments and reliability of hoisting equipment, the general rule is to store one full day's supply plus enough for over Sunday or holiday. If there is a possibility of sleet or heavy snow storms that might interrupt rail transportion for a few days, it is far more economical to store a few carloads of coal on the ground near the boiler house than to provide bunker capacity.

When planning overhead storage, it should be remembered that no bin of reasonable design is entirely self-cleaning. There is always a certain amount of "hang-up," this running between 10 and 20 per cent.

An overhead bunker should not be carried on columns supporting the boilers. The load in bunkers varies and is likely to have enough up and down motion to damage boiler walls. A bunker is best placed outside the boiler house. By this means, the most economical design of a boiler house, and one that will not obstruct light or ventilation and interfere with tube removals, can be worked out.

Quiescent coal in a bunker will ignite due to spontaneous combustion, but coal in motion never ignites from that cause. A round or square bunker with one outlet at its bottom is ideal, and this type is used for many modern small boiler plants. With a long bunker and individual spouts to each stoker, there is a segregation of the coal. The larger lumps flow to the outside edges of the stokers and cause unnecessary scouring of the side walls. This is one of the reasons for adopting the traveling weigh larry.

For the small boiler plant of, say, two or three 3,000-sq.ft. boilers, a 1,000-lb. hand-operated larry is satisfactory, but a larry of over 1,500-lb. capacity should be motor operated. The semi-automatic weigh larry is a recent development. Instead of a man walking beside or riding on the larry, it is equipped with an electrical control, and an automatic loading gate is installed on the overhead bin.

To obtain a coal supply, the fireman simply presses a button in front of any boiler. The larry, which has been automatically filled, travels to the selected boiler. After the larry has emptied into a stoker hopper, the fireman releases it and it automatically returns for another load.

Fig. 1 is an exterior view of a small boiler plant that is simply a room in a large manufacturing building. All of the coal-handling equipment is outside the boiler room. The boiler house is quite low, due to storing of the coal in a bunker over the roof.

Fig. 3 shows the firing aisle of a small boiler room. The hoisting engine for the skip, with its control enclosed in a steel cabinet, is in the corner. Note how well lighted the room is. The hoisting engine is where it can be kept clean and easily inspected. This installation is also a good example of a small larry. It is shown in position to receive coal through the chute from an outside bunker. Fig. 2 is a good example of a modern skip-hoist engine with its control enclosed in a housing.

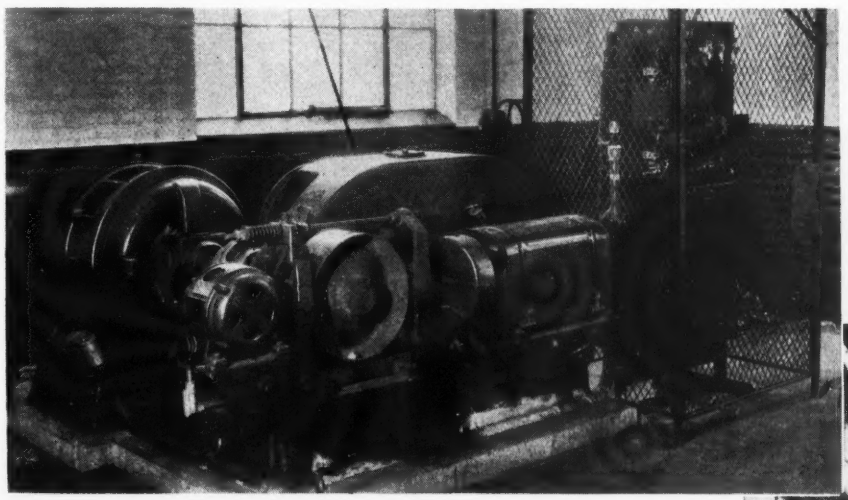
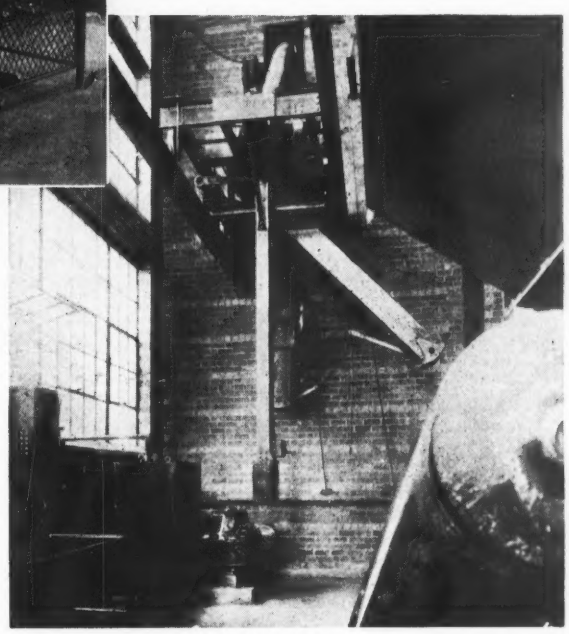


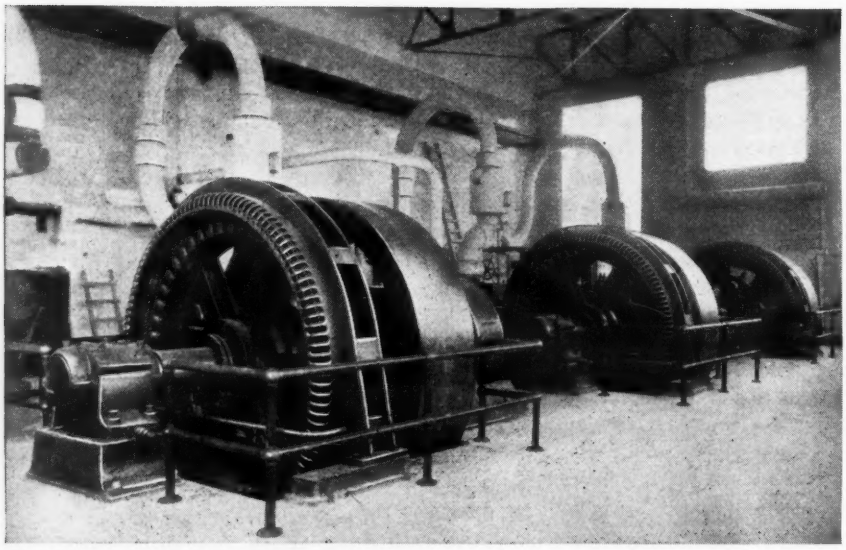
Fig. 2 (Left)—Modern skip-hoist engine and its control, the latter inclosed in a wire-mesh housing

Fig. 3 (Below)—Coal weigh larry in a small boiler plant. The larry is in place to take coal through the chute from an outside bunker.



A 1,500-KW. POWER PLANT

for the new RIKERS ISLAND CITY PRISON



Three 500-kw., engine-driven a.-c. generators are installed

Steam, power, light, heat, water, hot water and refrigeration are all provided by this isolated plant

ON RIKERS ISLAND in the East River, the City of New York is building a new penitentiary to replace the one on Welfare Island. Accommodations for 2,000 prisoners and the attendants are being provided in the present buildings, which comprise eighteen different structures. Provisions have been made so that the prison may be extended to provide for 3,000 inmates. A prison is not unlike a hotel in that it requires large quantities of steam for building and water heating and in the laundry and kitchens, which makes it economical to generate power in an isolated plant.

To provide power, light, heat and other services, a 1,500-kw. power plant has been installed, with space for an additional 500-kw. unit. There are also four small refrigerating systems, one comprising a 12- and an 8-ton compressor, another an 8-ton compressor, and the remaining two a 6-ton compressor each. All compressors are motor driven. Fire and service water are provided from a 200,000-gal elevated steel tank supplied by three motor-driven service pumps and a steam-driven duplex fire pump.

Coal for the power house is received by boat and unloaded by a hoist and clamshell bucket into an elevated car that delivers it to the storage yard. Because of the inmates a large amount of manual labor is available, therefore no mechanical means have been provided for recovering coal from storage. It is shoveled into trucks, hauled to the power house and dumped into a hopper over a reciprocating plate feeder that delivers to a 40-ton per hr. crusher. From the crusher, a bucket elevator delivers coal to the overhead bunker.

The power plant may be considered as comprising three separate parts: the engine room, the boiler room and the coal bunker, the latter being at one end of the boiler room. Keeping the coal bunker outside the plant permits better ventilation and natural lighting of the boiler room and makes the boilers more accessible for cleaning and repairs.

Four 5,110-sq.ft. water-tube boilers with longitudinal drums are installed, space being provided for a fifth unit if required in future. These are designed for 200-lb. gage working pressure, but will be operated at 150 lb. They are baffled for three passes, the front header is set 12 ft. above the boiler-room floor and it is 9 ft. 3 in. from stoker to the bottom row of tubes.

Each boiler is fired by a 7-retort underfeed stoker having a projected grate area of 94.5 sq.ft. They can operate the boilers continuously at 200 per cent of normal rating and at 250 per cent rating for four hours. Each stoker is driven by an alternating-current motor that has a speed range of from 450 to 1,200 r.p.m., which is sufficient to operate the boiler at from 75 to 250 per cent rating. Draft is provided by a 9-ft. diameter brick stack, 185 ft. high, and, on each boiler, a 13,000-c.f.m. steam-engine and motor driven forced-draft fan. Combustion is under full automatic control to regulate fuel feed, air supply and furnace pressure.

When burning a good grade bituminous coal of about 14,000 B.t.u., the stokers are guaranteed to give a minimum combined furnace and boiler efficiency of 78 per cent at 100 per cent rating, 77 per cent at 150 per cent rating, 75 per cent at 200 per cent rating, and 71 per cent at 250 per cent rating. Exit flue-gas temperatures at these ratings are not to be more than 470, 515, 550 and 600 deg. F. respectively.

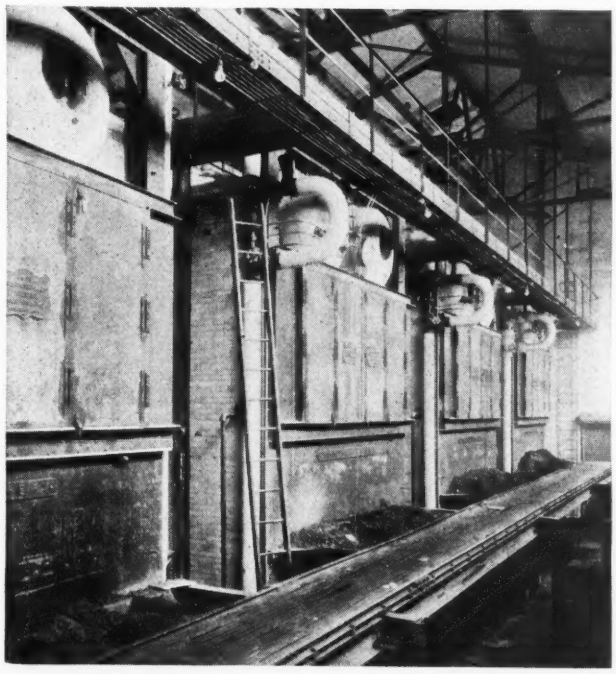
Coal is delivered from the bunker to the stokers by a ½-ton weigh larry that runs on an elevated track above the stoker hoppers. The larry is power-operated, carries the attendant and can weigh the coal to each boiler. A spare larry is provided.

On a gage board in the boiler room are installed for each boiler an integrating steam-flow meter with steam-flow and exit flue-gas temperature recorders and a boiler load indicator; one feedwater flow meter with temperature recorder, a flow meter on the 100-lb. steam line to the buildings; a return condensate flow meter and temperature recorder; four sets of draft gages, consisting of three gages per boiler; recording pressure gages on the high-pressure steam main, the exhaust steam main and on the 100-lb. steam line; and indicating

pressure gages. The draft gages are connected to give the pressure in the pressure chamber under the stokers, pressure over the fire and in the third pass of boiler.

All four boilers connect into a riveted receiver 36 in. in diameter, designed for 250-lb. working pressure, and made tight under 375-lb. working pressure. Connections are provided on this receiver for five boilers, four engines, two auxiliary steam lines, two heating lines, and three connections for gages and drips. The receiver was installed instead of a header to provide a steam reserve between boilers and engines to relieve the former of steam pulsations from the engines.

In the power house are three 625-kva., 480-volt, 3-phase, 60-cycle, engine-driven generators. The engines are horizontal, single-cylinder, 4-valve, non-releasing, non-condensing type and operate at 150 r.p.m. They will carry full load at 150-lb. gage pressure at the throttle with 12-lb. back pressure and not exceed 25 per cent cutoff. They have sufficient capacity to drive the generators at full load continuously, at 25 per cent overload for two hours and 50 per cent overload for one hour immediately after the 2-hour 25-per cent overload run. With 150-lb. gage pressure at throttle and zero back-pressure, the guaranteed steam rates per indicated horse-



The four boilers have 5,110 sq.ft. of heating surface each and are stoker fired

power-hour at 25, 50, 75, 100 and 125 per cent rated load are 25.1, 21.1, 21.2, 20.4 and 21.3 lb. respectively.

Flywheels are provided having a WR^2 that will, during parallel operation of the generators, prevent the maximum periodic displacement of the rotors from position of uniform rotation from exceeding 3.5 electrical degrees.

The generators are guaranteed to have efficiencies at 50, 75, 100 and 125 per cent rated loads and unity power factor loads of not less than 90, 91.5, 92.2 and 92.5 respectively. They are equipped with an automatic voltage regulator and are designed so that when carrying from 50 to 100 per cent of rated full-load amperes, evenly distributed between phases the instantaneous application or rejection of 15 per cent rated full-load amperes will not cause a perceptible change in the brilliancy of a 100-watt or larger tungsten lamp connected at the generator terminals.

All power, steam, and water lines are carried from the power house to the buildings underground in tunnels. Emergency lighting is provided through the building by a power supply taken from a feeder connection with the public utility company system on the mainland.

Sloan & Robertson, New York City, are the architects for the project; the general contractor is Erickson Equipment Co., Inc.; the contractor for the mechanical equipment including the power-house is Clark, MacMullen & Riley; the piping contractor is M. W. Kellogg Co., all of New York City. F. H. Phipps is engineer in charge of operation for New York City Department of Correction.

Principal Equipment, Rikers Island Plant

Boilers and Auxiliaries

Boilers: Number, 4; heating surface, 5,110 sq.ft.; gage pressure 200 lb. ..... Union Iron Works
Stokers: Number, 4; Number of retorts, 7; projected grate area, 94.5 sq.ft. ..... Detroit Stoker Co.
Stokers drive 7-5 hp., multi-speed, a.-c. motors ..... Louis Allis Co.
Automatic combustion control ..... The Engineer Co.
Feed-water regulators ..... Atlas Valve Co.
Soot blowers ..... Vulcan Soot Blower Corp.
Smoke indicator ..... T. W. McNeil Eng. Equipment
Water columns ..... Reliance Gauge Column Co.
Boiler settings ..... Fred W. Kaelber, Inc.
Chimney ..... M. W. Kellogg Co.
Breechings ..... Kittoe Boiler & Tank Co.
Forced-draft fans: Number, 4; 13,000 c.f.m., static pressure, 5 in. of water ..... B. F. Sturtevant Co.
Each fan driven by Troy Engine & Machine Co. steam engine and a Westinghouse motor.

Coal- and Ash-Handling Equipment

Coal-unloading and storage equipment at dock ..... R. D. Coombs & Co.
Coal elevator and crusher at plant ..... Robins Conveying Belt Co.
Coal weigh larrys ..... Easton Car & Construction Co.
Coal scale ..... Fairbanks, Morse & Co.
Ash-Handling equipment ..... Robins Conveying Belt Co.

Engine-Generators

Engines; Number, 3; horizontal, single-cylinder, 4-valve corliss; speed 150 r.p.m. ..... Erie Ball Engine Co.
Lubrication system ..... Hills-McCanna Co.
Generators: Number, 3; capacity, 625-kva.; 480-volt, 3-phase, 60-cycle, 0.80 p.f. ..... Westinghouse Elec. & Mfg. Co.
Exciters: Number, 2; one turbine- and one motor-driven; 50 kw., 125-volt ..... Westinghouse Elec. & Mfg. Co.
Switchboard meters and voltage regulator ..... Westinghouse Elec. & Mfg. Co.
Switchboard built by ..... Metropolitan Elec. Mfg. Co.

Turbines, Pumps, etc.

Feed-water heater ..... Elliott Co.
Boiler-feed pumps, one turbine-driven, one motor-driven ..... Worthington Pump & Mach. Corp.
Turbine ..... Moore Steam Turbine Corp.
Motor ..... Westinghouse Elec. & Mfg. Co.
Feed-pump governor ..... Fisher Governor Co.
Service, fire, wash-down and condensate pumps ..... Worthington Pump & Mach. Corp.
Service, wash-down and condensate pump motors ..... Westinghouse Elec. & Mfg. Co.
Pump-motor controllers ..... General Electric Co.

Instruments

Steam-flow and temp. recorders ..... Brown Instrument Co.
Boiler-load indicators ..... Brown Instrument Co.
Draft gages ..... Ellison Draft Gage Co.
Recording pressure gages ..... Brown Instrument Co.
Indicating pressure gages ..... Brown Instrument Co.
Indicating pressure gages ..... Crosby Steam Gage & Valve Co.

Valves and Fittings

Safety valves ..... Crosby Steam Gage & Valve Co.
Surface blowoff valves ..... Everlasting Valve Co.
Blowoff valves ..... Yarnall-Waring Co.
Nonreturn valves ..... Foster Engineering Co.
Globe valves ..... Wm. Powell Co.
Reducing valves ..... Foster Engineering Co.
Gate valves ..... Wm. Powell Co.
Check valves ..... Wm. Powell Co.
Swing gate valves ..... Kennedy Valve Mfg. Co.
Twin strainers ..... Elliott Co.
Steam separators ..... Crane Co.
Oil separator ..... Swartwout Co.
Expansion joints ..... Joseph Kopperman & Sons
Traps ..... Bundy Steam Trap Co.
Piping ..... M. W. Kellogg Co.
Pipe covering ..... Daniel R. Douglas

Miscellaneous

Air compressor ..... Gardner-Denver Co.
Travelling crane ..... Armington Engineering Co.

TWO MAY LIVE MORE CHEAPLY THAN ONE—WHEN

MOTOR WEDS

MECHANICAL TRANSMISSION

Marriage has been, traditionally, one method of slowing a man's speed. But when high-speed motor and mechanical power transmission are made one, installation is simplified, space is saved, and cost and weight are also reduced

COMBINATION of electrical and mechanical drive is more economical for many power applications than an entirely electrical drive. Where the driven shaft operates at medium or slow speed, a high-speed motor and some form of speed reducer is generally cheaper and more efficient than a slow-speed motor directly connected to the machine. When speed changes are required, a constant-speed motor and a mechanical variable-speed unit often is more economical than an adjustable-speed or a variable-speed motor.

Recognizing these simple fundamentals, manufacturers of power equipment have directed their attention to combining the motor and mechanical power-transmission device. One outstanding development of this kind is the geared-motor speed-reducer, which is now available under several names, such as gearmotor, motorized speed reducer, motorized gear reducer and motor-reducer unit.

These are available in three forms. The first is the gear-head motor, Fig. 1, where the speed reducer is built in as part of the motor frame. This type of construction is used for speed ratios up to about 10 to 1. Above this ratio, torsional stresses of the low-speed shaft become too great to be taken by the motor frame and feet. Such a unit for maximum speed ratio may, for example, consist of an 1,800-r.p.m. motor and a reduction gear to give 180 r.p.m. on its output shaft. Other types of single-reduction units are available for much higher ratios, as will be seen later.

The second, Fig. 2, consists of a double-reduction-gear speed reducer of such proportions as to stand on its own feet and support the driving motor. The speed-reducer frame is substituted for the end bell of a round-frame motor, and the first pinion of the gear train is mounted on the motor shaft. This form is for the higher speed ratios.

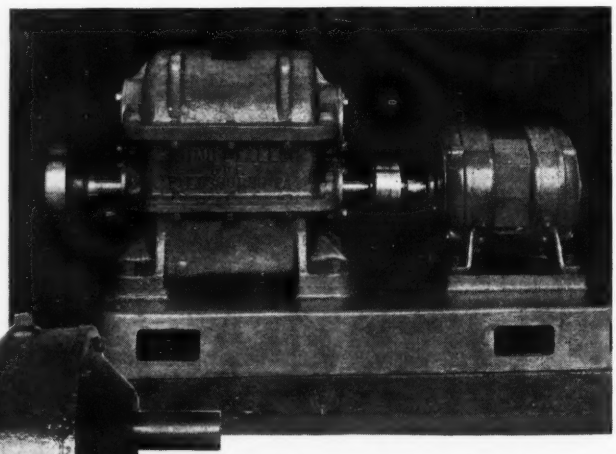
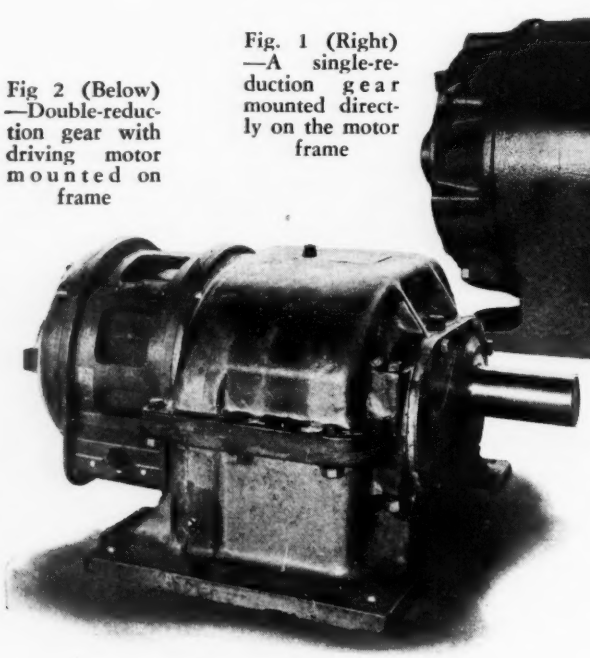


Fig. 3—Motor and gear speed reducer mounted as separate units on a bedplate

Fig. 1 (Right)—A single-reduction gear mounted directly on the motor frame

Fig 2 (Below)—Double-reduction gear with driving motor mounted on frame



The third is that in which a standard motor is mounted on an extension of the reduction gear frame and is connected to the gear input shaft by a flexible coupling. This construction lacks the compactness of the other two combinations. It has the advantage of the gear and motor being mounted as a unit and is more flexible than its prototype because the motor can be easily exchanged for a spare in case of trouble.

A comparison of the combination motor and speed reducers, Figs. 1 and 2, with Fig. 3, the latter showing

a motor coupled to a speed reducer, clearly indicates the compactness of the former designs. In addition, motorized units have the advantage that gear and motor are permanently in alignment. The feature of interchangeability of the type shown in Fig. 3, because of the reliability of modern equipment, is not of such importance as it formerly was.

These motorized units combine the desirable characteristics of a high-speed motor with a high-efficiency gear to provide almost any speed to the driven machine shaft. Single-reduction gears are available that have over 98 per cent efficiency and double-reduction gears with efficiencies of from 96 to 98 per cent. The high-speed motor is not only more efficient, lower in cost and of smaller dimensions than the slow-speed type, but in the case of induction types has a much higher

Fig. 4—Westinghouse multi-speed gearmotor

power factor. Where power is purchased, this feature alone may amount to as much as a 20 per cent difference in power costs in favor of the high-speed motor.

The reduction in cost and weight of motorized speed reducers, compared to slow-speed induction motors to give the same speed, will vary with the speed reduction. For example, in a 5-hp. 1,800-r.p.m. motor combined with a speed reducer to give an output speed of 290 r.p.m. the cost may be only 30 per cent and the weight about one-sixth of that of a motor designed to operate at 290 r.p.m. With a speed reduction of about 2.5 to 1 the gearmotor will cost about 33 per cent less, and weight will be about 20 per cent less, than for a 690-r.p.m. motor.

For small-capacity units, motorized speed reducers are available for ratios up to 3,000–1. With motors up to 10-hp. capacity, units can be had with speed ratios of 450–1. There is a limit to the size of gear unit that it is economical to motorize. One manufacturer has set this limit as around 50 hp. with gears of average ratios, but gearmotors are available up to 75 hp. capacity. These combination units, as now generally constructed, are not suitable for severe applications. For such service, manufacturers of the units should be consulted to make certain that the drive is suitable before making the installation.

Several types of gearing are used in both single and double reductions. Worm-gear units have the advantage, for certain applications, that the unit can be placed parallel with the driven machine. The output shaft is at right angles to the motor, therefore the unit can be installed in small space. Units for single reductions up to about 80 to 1 are available, designed so that the output shaft can be adjusted to four different positions by rotating the gear housing on the motor frame. For very low speeds, double-reduction worm gear units are used. In some cases, the intermediate gear shaft is extended from the housing so that two speeds are available from the same unit.

Parallel-shaft gear units in which the slow-speed shaft is parallel with the motor shaft are built, using different types of gears, such as herringbone, helical and spur. Both gear and pinion are ordinarily made of steel, but where quietness is a factor a composition gear may be used. In some designs of these units, the gear housing can be turned to four positions so that the output shaft will be either above, below or on either side of the motor shaft.

Various types of geared motors are equipped with planetary gear reducers. Such equipments are available in sizes up to 75 hp. and speed ratios up to 150–1. They can be had for horizontal, vertical and right-angle drives. On another type of geared motor, speed reduction is obtained by a planetary adhesion-type drive. In this type, adhesive rings are used instead of gears.

A recent addition to the gearmotor family combines the motor, gear and a snub starter-type centrifugal friction clutch that transmits a definite and constant torque at any given speed. This combination eliminates the necessity of using high starting-torque motors, keeps down peak loads during starting and reduces the cost of starting equipment.

When speed changes are required, frequently a number of fixed speeds will meet the requirements. Where alternating current is available, multi-speed motors have come into extensive use for these applications. A geared-motor unit, Fig. 4, comprising a simple high-speed squirrel-cage motor and a four-speed gear, has been developed for drives where multi-speed motors were formerly used. With this drive, the speed may

Fig. 5—Motor mounted directly on an inclosed variable-speed transmission to form a unit

be changed by the movement of a lever while the motor is running at full speed and under full load. Standard sizes of these units include 21 different motors in ratings of 0.5 to 15 hp. with a maximum speed range of about 1–3.75. For example, a 10-hp. unit having a 1,160-r.p.m. motor can be had with output-shaft speeds of 431, 700, 1,085 and 1,428 r.p.m.

To get more compact units, the motor is being combined with variable-speed transmissions. Fig. 5 shows a high-speed induction motor mounted on an inclosed variable-speed transmission that has two pairs of beveled disks on parallel shafts and connected by a V-shaped belt to fit the vee formed by the disks. The motor is connected to the input shaft of the transmission by a chain drive, and the output shaft is connected by another chain drive to a countershaft to obtain a low speed at the input shaft of the driver machine, say, from 25 to 150 r.p.m. This unit is arranged so that speed may be varied manually by a handwheel. Units also can be had for electrical remote or full-automatic speed regulation and are available for speed ranges of 16 to 1 and in sizes up to 150 hp.

Power equipments are now built that combine reduction gears, clutches and other mechanical power-transmission devices with the motor. By this means the equipment is all assembled in the shop on a single bedplate ready to set on the driven machine. The only alignment that has to be made is of the power unit half of the coupling with that on the driven machine. This greatly simplifies the installation of the equipment and its maintenance. Since the power unit is equipped with anti-friction bearings, it should give little trouble for many years if not overloaded and properly lubricated.

"THREE-IN-ONE" ISN'T ALWAYS OIL

This month POWER will publish an additional issue of exceptional interest and value to every reader. Three distinct sections will be included in this thirteenth number. They are:

1—The Annual Equipment Review

Every new or improved product offered to the power field in 1933 and previously described in POWER will be reviewed, illustrated and the maker's name listed. More than 300 items of power equipment will be included—an index that will be highly helpful to every power engineer.

2—Reports of A.S.M.E. Meeting

The annual meeting of the American Society of Mechanical Engineers is being held in New York City, Dec. 4-9. POWER editors will attend every convention session of interest to power men, will sift out important happenings, analyze and report practical conclusions. This will be the first report, by several weeks, for power engineers.

3—The Executive Section

A grand new departure this—the dollars-and-cents story of the power services for top executives not technically familiar with the power problems with which they sometimes deal. This 16-page section, easy to read, will promote a better understanding between engineers and management.

MAILED DECEMBER 20

BOOSTER PUMPING PLANT FOR WASHINGTON AQUEDUCT

A BOOSTER pumping plant to increase the water supply and the effectiveness of the purification system of Washington, D. C., is being built. This work is being handled by the engineers of the United States Engineer Office in that city.

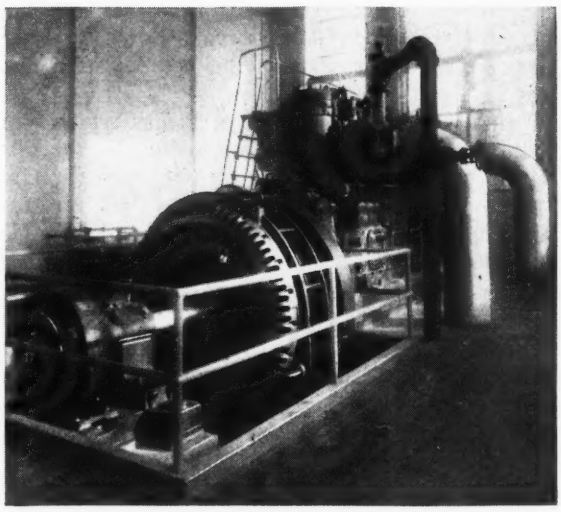
The water supply is taken from the Potomac River at Great Falls, Md., and flows about 9 mi. through two conduits to the receiving or Dalecarlia reservoir. The conduits have a fall of about 9 in. to the mile, and because of this flat grade they can pass a maximum of 200 million gallons a day with the reservoir drawn down. It is for the purpose of increasing the flow through the conduits and increasing the head of the purification plants that the booster pumps are being installed.

The booster station is a part of a dam about 200 ft. long across the upper neck of the reservoir which will act as a forebay. The pumps will lower the water in the forebay, thereby increasing the flow through the conduits to about 217 million gallons a day, and raise the water in the reservoir below the dam. The static head between the two parts of the reservoir will be 7 ft.

To accomplish this, the station will be equipped with three 75,000-g.p.m. and one 15,000-g.p.m. pumps of the vertical DeLaval mixed-flow type, direct connected with 200-hp. motors on the larger pumps and a 40-hp. motor on the smaller. The large pumps, 66 in. in diameter, will be of the volute type, with plate-steel suction and discharge bells, the suction being vertical and the discharge horizontal but dipping downward below water level to permit priming. The smaller pump is of a similar design, but is 36 in. in diameter. Each gland and bearing of the pumps will be equipped with a thermal protective relay designed to interrupt a control circuit should the gland or bearing temperature exceed 50 deg. C. Each of the main pumps will be equipped with a 12-in. motor-operated vacuum breaker gate valve with Cutler-Hammer control for the prevention of syphoning back the high level reservoir when pumps are shut down.

The motors for driving the main pumps will be Electric Machinery Company synchronous 2,200-volt, 3-phase type designed to operate at 100 per cent power factor, and free from dead points. They will be mounted directly on the pumps.

Since the pumps will operate continuously, the efficiencies of the units was a major consideration in the award of the contract. A normal expected over-all efficiency of 70 per cent was specified for the main units. The contractor was required to guarantee a definite efficiency, and a bonus of $1,500 per unit will be paid for each per cent above the guarantee, and liquidated damages of $3,000 will be subtracted for each per cent below the guarantee as shown by tests of the completed installation. The De Laval Steam Turbine Company is the contractor for the pumping units.



Adding DIESEL to STEAM SAVES $18,000 FOR MARSHALL, MINN.

By HELMER N. ANDERSON, M.E.
Manager, Diesel Dept., Fairbanks, Morse & Co., St. Paul, Minn.

BY ADDING a diesel engine to overcome exhaust steam losses during the summer months, Marshall, Minn. is saving $17,000–$19,000 in operating costs in its municipal plant this year. The city has owned and operated a municipal plant for many years. Providing steam, heat and water in addition to power, the plant has shown an average annual profit of $25,000 after deducting all interest and depreciation. In addition, free lighting of streets and public building, pumping services and heating of public buildings represent an additional saving of $9,000 annually.

In 1931, a power company offered $460,000 for the electric generating plant and distribution system, payable over 20 years, providing the company received a 20-year exclusive franchise to sell electricity to inhabitants. This was voted down at an election, Jan. 12, 1932, by a vote of 1,289 to 99. It excited so much interest, however, that an investigation was immediately begun on power-plant modernization.

Equipment at that time was steam-engine generating units exhausting into the municipal buildings' steam heating system, or exhausting to atmosphere when heat was not required. A new steam turbine condensing during the summer months, bleeder type for low-pressure steam and a steam-diesel plant all were considered and many municipal plants of both steam-turbine and diesel generating types were investigated. This led to selection of a diesel engine to operate in combination with the existing steam equipment to give best heat balance.

No low-pressure steam is required during the summer months and only a small amount during April, May, September and October. Therefore, the steam engines could furnish electricity and exhaust to the heating system during the remaining five cold months, with the diesel for standby and peak-load periods only. The diesel unit would operate alone during the summer, spring and fall months.

G. M. Orr Co., consulting engineering firm of Baker Bldg., Minneapolis, Minn., who made the preliminary studies, drew plans for the diesel generating unit. The contract was awarded to Fairbanks, Morse & Co., St. Paul, Minn., for an 875-hp. (605-kw.) 2-cycle, solid-injection diesel. It was installed in the winter of 1932, and took load during January, 1933.

Table I shows the equipment installed and load data. The Ball and Lentz engines operate normally on 125-lb. steam pressure, 1½-lb. back pressure on the heating main. The Nordberg engine operates on 185-lb. pressure and 1½ lb. on the heating main. The heating system is of the vacuum type.

Steam Heating Department sales approximate 22,000,-

Table I—Equipment and Load Data

Generating Equipment	Age, Years	Capacity, Kw
Lentz Steam Engine	19	125
Ball Steam Engine	17	120
Nordberg Uniflow Steam Engine	5	400
Fairbanks-Morse Diesel Engine	1	605
Total Combined Capacity		1,250

Peak Load, kw	660
Average Load, kw	230
Minimum Load, kw	100
Normal Day Load, kw	250 to 400
Normal Evening Load, kw	400 to 600

Boilers	Age, Yrs.	Heating Surface Sq. Ft.	Maximum Load Thousands lb. Steam per Hour	Method of Firing	Steam Pressure (No Superheat)
2-Bros Fire Tube (Ea. 1,500 sq. ft.)	19	3,000	8.1	Hand	135 lb.
2-Wickes Water Tube (Ea. 2,000 sq. ft.)	20	4,000	11.1	Stoker	135 lb.
1-Connelly Water Tube	3	4,600	27.6	Pulv. Coal	199 lb.

Table II—Generation Costs, Steam-Diesel Plant
Compared with Steam Plant, 8 Mos., 1932 and 1933

	Feb.	March	April	May	June	July	Aug.	Sept.	Total
Kw.-hr. Generated	185,000	154,900	165,900	163,600	185,500	192,100	184,500	190,400	1,421,900
Generation Cost including salaries, fuel, lub. oil, repairs, supplies, etc., etc.	$3,262	$2,714	$2,599	$2,137	$1,658	$1,360	$1,332	$1,604	$16,666
Plant Operating Cost per kw.-hr	1.76c	1.75c	1.57c	1.30c	.89c	.71c	.72c	.84c	1.17c
Fuel Cost: Coal & Oil; Cost Coal $4.95 per ton; Oil 3½c to 4c per gal.	$1,938	$1,629	$1,517	$1,303	$839	$718	$723	$727	$9,394
Fuel Cost per kw.-hr	1.05c	1.05c	.91c	.8c	.45c	.37c	.39c	.38c	.66c
GENERATING COSTS—STEAM PLANT—EIGHT MONTHS, 1932									
Kw.-hr. Generated	179,900	175,300	165,100	166,300	168,700	166,200	179,800	182,800	1,384,100
Operating Cost including salaries, wages, fuel and lub. oil, repairs, etc.	$3,610	$3,757	$3,394	$3,763	$3,908	$3,457	$3,296	$3,442	$28,627
Operating Cost per kw.-hr	2.01c	2.14c	2.06c	2.26c	2.32c	2.08c	1.83c	1.88c	2.07c

000 to 28,000,000 lb. per year. Losses are estimated at 20 per cent, since 26,000,000 to 33,000,000 lb. are sent out annually. Electric Department sales approximate 1,750,000 kw.-hr. annually; generation 2,000,000 kw.-hr.

Table II compares 8-months operation of the combined steam-diesel plant in 1933 with the operation as a steam plant during the same period of last year. Table III gives a further comparison of generating costs, showing all costs on the basis of 1933 business. From this table it will be noted that operating savings of the new system over the old are between $17,000 and $19,000 annually. These savings are due to two improvements: reduction in fuel required due to operation of diesel alone during summer months (this accounts for about two-thirds of the annual saving); economies made by Supt. George Wombill by obtaining better boiler efficiency and better results in the plant in general.

Table III—Comparison of Generation Costs
Steam-Diesel Compared with Steam, 8 Mos., 1932 and 1933

		Per Kw.-hr.
Kw.-hr. Generated, 8 Months, 1933	1,421,900	.....
Operating Expense: *Basis* of 1932 Steam Plant Operation (8 Mo.)	$29,433.00	2.07c
Actual Operating Expense, Combined Steam and Diesel Plant, (8 Mo.)	$16,666.00	1.17c
SAVINGS Combined Steam & Diesel Plant over Steam Plant—8 month's time	$12,767.00	.90c

Similar Data for Four Summer Months
June, July, August, September

Kw.-hr. Generated, 4 Months, 1933	752,500	.....
Generation Expense: *Basis* of 1932 Steam Plant Operation (Summer Period)	$15,200.00	2.02c
Actual Generation Expense: Combined Steam and Diesel Plant (Summer Period)	$5.954.00	.79c
SAVINGS Combined Steam and Diesel Plant over Steam Plant for 4 Summer Months	$9,246.00	1.23c

One item of particular interest in the installation is that the diesel operated through June, July and August, when the steam heating season was off, without standby. Boilers were cold and fires dead. The diesel has now operated four months continuously with only one shutdown of five hours due to a shortage of fuel.

Cooling of the diesel is handled by a dual system consisting of a 2-pass heat exchanger with raw water passing through one side and soft water through the other. Piping is so arranged that the soft-water pump draws water from the concrete soft-water basin, pumps it through the heat exchanger where the soft water is cooled by the raw water, to the engine jackets for cooling the engine, and back to the hotwell. A 5,000-gal. steel surge tank on the roof floats on the line. In the event the soft-water pump fails, an alarm sounds, a red light lights, and the surge tank will handle the engine cooling for approximately ten minutes, during which period the operator must get the spare pump into operation.

The raw-water pump draws water from the concrete cooling tower basin, forces it through the oil cooler, then through the heat exchanger, where it is cooled itself after going through the spray nozzles. The cooling tower, a 1,000-g.p.m. combination forced-draft and atmospheric type, is of sufficient capacity for double the present plant.

The engine has oil-cooled pistons, oil being pumped through a built-in oil pump, forced to all the bearings, then to the piston (for cooling) and back through the oil cooler to a sump in the engine base. A duplex strainer in the line cleans the oil. An electrically driven pump is provided for emergencies to keep the plant running in case the built-in pump breaks down, and this pump is also used for cooling the engine after it is shut down.

The engine is equipped with wiper rings which wipe the carbonized oil off the piston walls and drain it into the dirty oil tank. One fuel-oil transfer pump pumps the oil through a centrifuge and into the clean oil tank, where the other transfer pump picks it up and transfers it to the engine. Each tank is 42x54x48 in. The centrifuge is equipped with a 6-kw. heater with 3-way snap switch.

Fuel oil is received by railroad. It is pumped from the tank cars into a 20,000-gal. storage tank by means of a 20-g.p.h. electric pump, and from storage into a 500-gal. day tank as required. Fuel is measured by a Master oil meter.

Two air starting units are provided, both 2-stage compressors, one driven by a 3-hp. motor, the other by a gasoline engine. The compressors each have a displacement of 10.2 cu.ft. of air per min. and compress air to 250-lb. pressure. Starting air tanks, each 26x96 in. and built according to the A.S.M.E. Code, are in the engine room.

Air for the engine is drawn through an intake stack 30 ft. high, through a silencer and air filter house (outside power house), then through the air intake pipe to the scavenging air pump. Scavenging air pressure is 2.7 lb. Exhaust is carried through an underground exhaust pipe to a concrete conduit, then vertically through a silencer and stack 40 ft. high.

Principal Added Equipment, Marshall, Minn., Plant

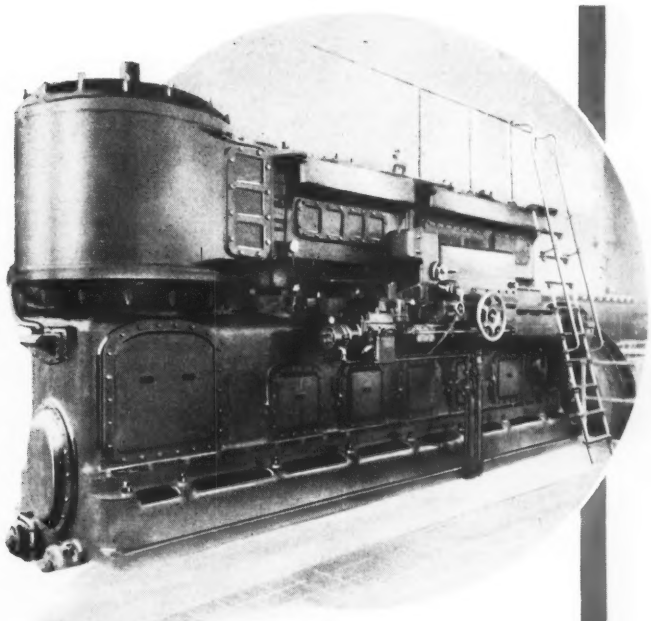
One 875-hp., 5-cyl., 16x20-in., 2-cycle, mechanical-injection diesel engine, 300 r.p.m., oil-cooled pistons, pump scavenging	Fairbanks, Morse & Co.
One 757-kva. (605-kw.) 3-phase, 60-cycle, 2,400-volt, 300-r.p.m. engine-type alternator	Fairbanks, Morse & Co
One 10-kw., Type MX direct connected, shunt wound exciter	Fairbanks, Morse & Co.
One 8-12x2-pass heat exchanger	Schutte-Koerting Co.
Three 4-in., split-case centrifugal pumps, direct-connected to 10-hp., 1,800-r.p.m. ball bearing motors, 500-g.p.m. @ 60-ft. head	Fairbanks, Morse & Co.
One 1,000-g.p.m. combination forced draft and atmospheric type cooling tower, on concrete basin, with two propeller-type 2 blade fans, each direct-connected to a 5-hp., 1,750-r.p.m. F-M motor	Cooling Tower Co.
One single-pass size 6-36x oil cooler	Schutte-Koerting Co.
One Model 20 Hydroil centrifugal oil purifier	Gould Pumps
Two fuel-oil transfer pumps, 60-g.p.h.	Fairbanks, Morse & Co.
One 20-g.p.h., 1-in. centrifugal pump direct-connected to 1-hp., 1,800-r.p.m. ball bearing motor	Fairbanks, Morse & Co.
One 2-stage air compressor driven by a 3-hp., 1,800-r.p.m. motor	Fairbanks, Morse & Co.
One unit as above, but engine driven	Fairbanks, Morse & Co.

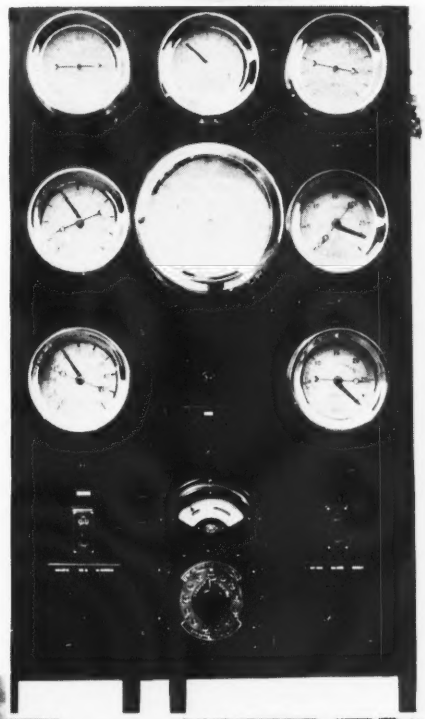
World's Fastest Tops—Two reports of ultra-fast tops, both used for centrifuges, have been received by *Power*. The first was exhibited before the Pacific Division, American Ass'n for the Advancement of Science, by Dr. J. W. McBain of Stanford University. Air driven, it spins up to 660,000 r.p.m., exerting a centrifugal force 3,000,000 times greater than the gravitational force of the earth. Invented by two Belgian scientists to measure the speed of light, it has also been used for many other things. Metals placed in the ultra-centrifuge recrystallize, and lead flows like water without heating. Other experiments by biologists have shed additional light on the nature of the living cell. The rotor is chrome-nickel steel.

The other is a centrifuge designed to run at 1,000,000 r.p.m., will be exhibited by Sharples Specialty Co. at Booth 59 of the Chemical Show in New York, Dec. 4-9. No details of its design are available.

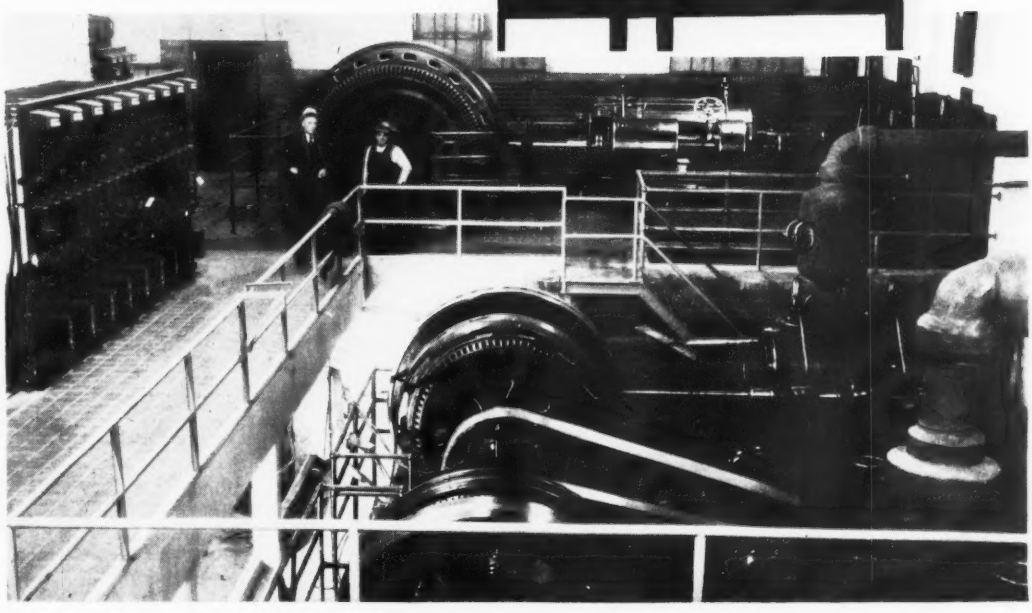
STEAM AND DIESEL JOIN FORCES

IN CITY POWER PLANT





Marshall, Minn., last year added the 875-hp., 2-cycle diesel at upper right to its municipal power, light and water plant. The lower illustration shows the three steam engines, and, at left, one end of the 20-panel switchboard. The diesel control switchboard appears at right. Combining steam and diesel in this case is saving $17,000 to $19,000 per year in operating costs. The diesel is shown from the scavenging pump end



STEAM ENGIN

● Moisture in steam interferes with cylinder lubrication in two ways. It tends to wash off the lubricating film supplied by the oil and the surface which it has already moistened is difficult to cover with an oil film. Wet steam conditions require an oil that will properly emulsify with water. Such an oil must readily replace any water present on the surfaces and after having built up an oil film it must resist being removed by the water.

Since the water always present under wet steam conditions constitutes the largest single factor adversely affecting the lubrication of steam cylinders, anything which can be done to reduce the quantity of the moisture contained in the steam will be of assistance in securing better lubrication. The installation of an efficient separator just ahead of the throttle will greatly assist in preventing excess moisture, and impurities from the boiler, gaining access to the engine cylinder. A mistake is often made by not installing a separator of sufficient size to properly remove the moisture. While any separator will be of appreciable assistance, one of proper size will give much more efficient results. The separator should be drained through a trap and where the steam contains appreciable impurities, frequent inspections and cleanings are necessary to prevent improper operation due to deposits.

Moisture in the steam at the throttle may come from two sources. Condensation of steam in the steam line is the first of these. Long steam lines cause greater condensation of steam than short lines; also non-insulated or poorly insulated lines cause excessive steam condensation. These must be avoided wherever possible. Steam lines which are too large in capacity will promote condensation since the velocity of the steam through the line will be so low that time is permitted for excessive condensation to take place. Long lines should be equipped with traps at suitable points to drain the water and prevent it reaching the cylinder.

Another source of water in steam is priming and foaming of the boiler. The combined concentration of dissolved solids and suspended solids that appear in feed water is the biggest cause of boiler foaming. These consist mainly of chlorides, phosphates and sulphates of calcium, magnesium and sodium. All are soluble in cold water, but many of them are only slightly soluble at boiler temperatures. When they are present in sufficient concentrations to cause foaming or priming appreciable quantities are entrained with the steam and carried into the engine cylinder. Much of this material is abrasive and contributes greatly to serious erosion and sticking of parts which ultimately may result in the costly expense of cylinder reboring and replacement of valves and piston rings. Priming and foaming of boilers usually can be reduced by more frequent blowing down of the boiler and improving the condition of the feed water. Suitable dry pipes also may be of assistance in reducing or preventing foaming. It should be eliminated, if possible, not only because of the detrimental effect on lubrication of the water it causes in the steam, but also because of the serious results of the dirt and abrasive material carried into the cylinder under such conditions.

In the operation of reciprocating steam pumps appreciable water often is encountered in the cylinders even though the quality of the steam leaving the boilers is good. Where the pump operation is intermittent or very slow, the steam condenses in the line near the pump and when the valve is opened slugs of water enter the cylinder. The resultant washing effect is very severe and a cylinder oil with unusual ability to resist the washing action of water is required under such circumstances.

In addition to having the ability to replace any water present on the surfaces to be lubricated and resist removal by water, the oil must also atomize quickly and completely. The temperature of wet steam is lower than that of dry steam and superheated steam. This has less thinning effect on the oil, consequently, oils for wet steam should be lighter bodied than those for dry and superheated steam to assist in atomization of the oil.

The oil should be introduced into the steam line five or six feet ahead of the throttle unless limited to a shorter distance by the position of the separator. To obtain the full effect of the velocity of the steam and prevent the oil from dribbling down the inside of the steam pipe, the oil line should extend to the center of the steam pipe. A tip, for the oil feed line, consisting of a straight $\frac{3}{8}$" pipe cut off square at the end is a very practical aid in atomization as it functions well as an atomizer and does not readily clog up from deposits.

The nature of the oil should be such as to give a uniform film of oil over valves, pistons, rings and cylinders. Only an oil which gives a uniform film can be fed in small enough quantities to provide economical oil consumption. Any other must be fed in excessive quantities causing pools of oil to collect in counterbores, etc., tending to increase cylinder deposits. Excessive feed of oil for any cause is detrimental where the steam is used for process work or the condensate is used for boiler feed water.

The oil itself must be properly refined and carefully manufactured so it will have no tendency to form gummy or carbonaceous deposits in the cylinders or on the valves and rings.

In conclusion it is seen that to be a completely satisfactory steam cylinder oil for use under wet steam conditions, the oil used must possess all of the following characteristics:

1. Atomize quickly and completely.
2. Give complete and uniform coverage of valves and cylinders.
3. Replace any water present and resist removal by water.
4. Give maximum freedom from carbon or gummy deposits.

Of the above four characteristics, the ability of the oil to replace any water present and resist removal by water is by far the most important characteristic for use under wet steam conditions.

NRA MEMBER U.S. WE DO OUR PART

STANDARD OIL COMPANY
(Indiana)

910 South Michigan Avenue — Chicago, Illinois

1324

LUBRICATION

STANDARD OIL COMPANY (INDIANA) SERVICE

A NEW TYPE OF CYLINDER OILS

StanoCyl Oils are a new development in steam cylinder oils. They are radically different from the conventional types of cylinder oils, and have characteristics never before combined in one oil.

They atomize quickly and completely.

They give complete and uniform coverage of the valves and cylinders.

They have the ability to replace any water present and to resist removal by water.

They give maximum freedom from carbon or gummy deposits.

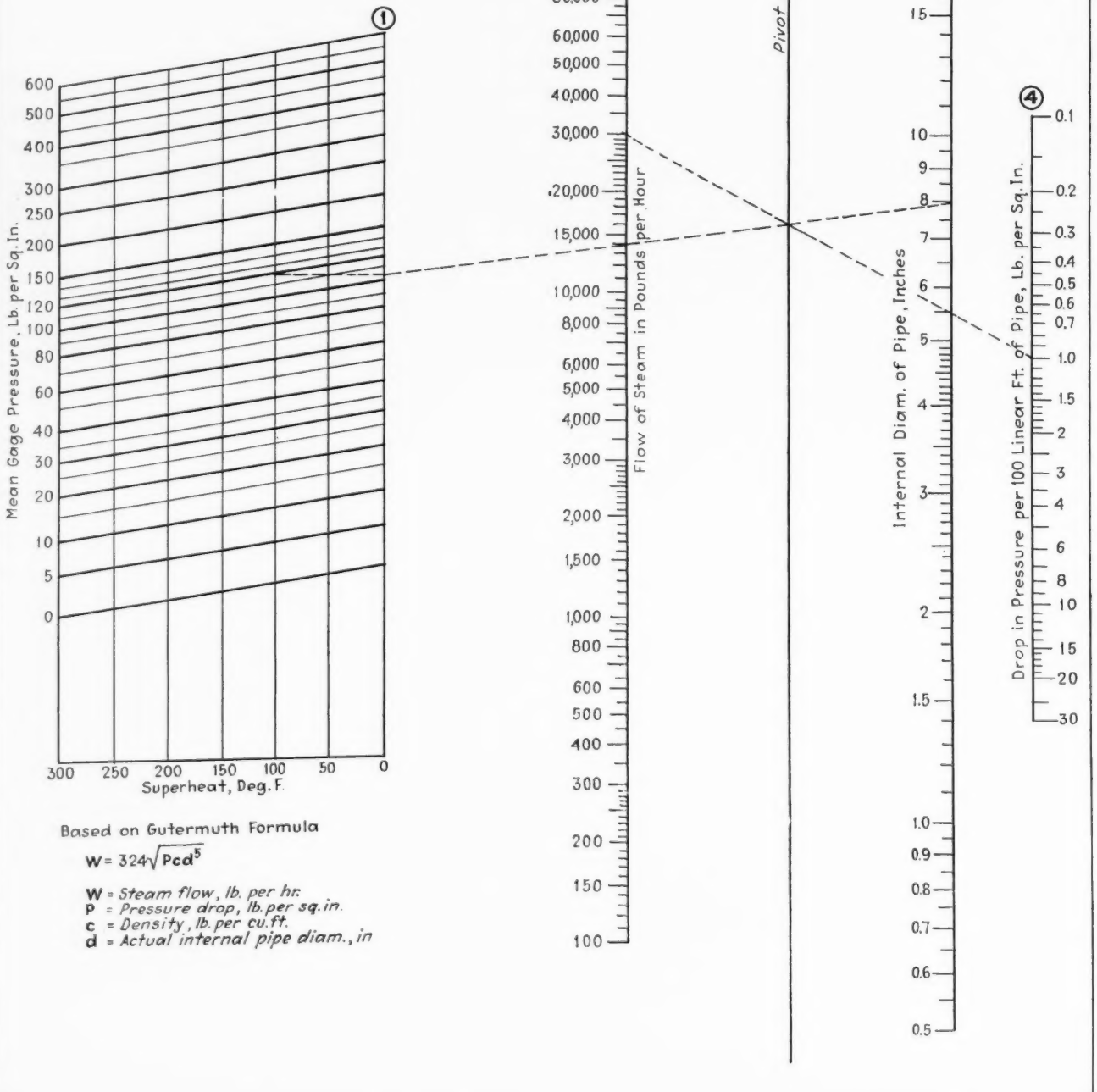
The three grades of StanoCyl meet any conditions encountered in present day practice. Usually StanoCyl "SH" is recommended for extremely severe conditions. StanoCyl "D" is advised for all average conditions. For particularly wet conditions, StanoCyl "W" is best. It will be found especially effective for Corliss engines where difficulty has been experienced due to wet steam conditions.

Why not investigate StanoCyl oils?

PRESSURE DROP IN STEAM PIPING

Example: *Steam flow, 30,000 lb. per hr.; initial pressure 125 lb. per sq.in. gage; superheat, 100 deg. F. Final pressure desired is 115 lb. per sq.in. gage. Equivalent length of pipe, 1,000 ft.; pressure drop per 100 ft., 1 lb.; average gage pressure, 120 lb. per sq.in.*

Find necessary pipe diameter
Join 30,000 on Scale 2 to 1 on Scale 4. Locate intersection of 120-lb. diagonal and 100-deg. vertical and proceed horizontally to Scale 1. Project line from this point on Scale 1 through intersection on pivot line to Scale 3. Final answer on Scale 3 – 8 in. diam. pipe



Based on Gutermuth Formula

$$W = 324\sqrt{Pcd^5}$$

W = *Steam flow, lb. per hr.*
P = *Pressure drop, lb. per sq.in.*
c = *Density, lb. per cu.ft.*
d = *Actual internal pipe diam., in*

By E. Cowan, *Industrial Engineer*

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FLOW METERS

CONTROL HEATING SYSTEM

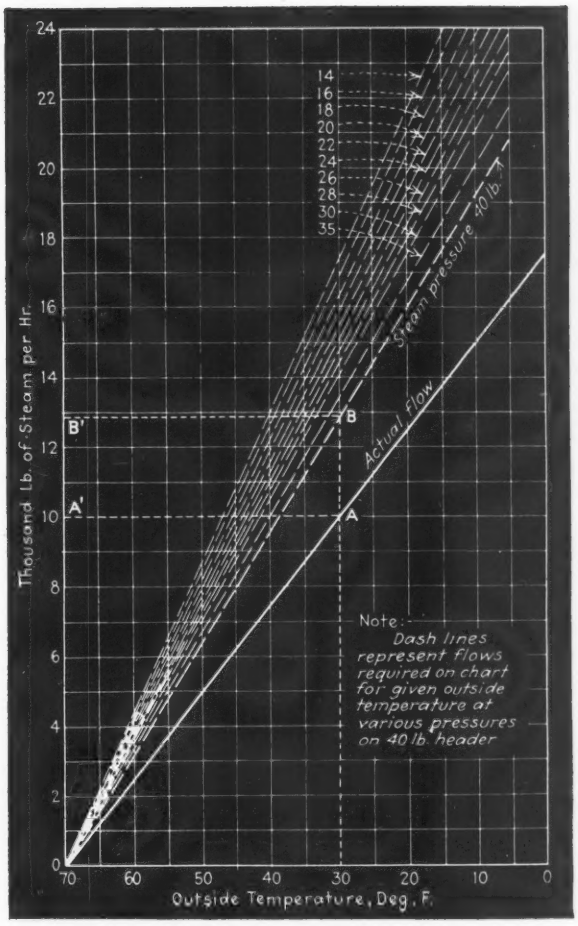
By G. D. TURNER
Supervising Engineer,
Chrysler Building

FIFTEEN per cent less steam was used for heating the Chrysler Building, New York City, last year than had been used the year before, even though the winter was 7 per cent colder. This saving was accomplished by adjusting reducing valves until steam consumption, as indicated by flow meters, corresponds with a curve showing steam required for various outside temperatures. The curve is shown on this page.

New York Steam Corporation supplies steam to the building at 135- to 140-lb. pressure, which is metered and reduced to 80 lb. by New York Steam equipment. The pressure is again reduced to 40 lb. by two Curtis regulators which discharge through the 18-in. main distributing header.

Steam supplied from the main header to the direct heating systems is metered by two Brown electric flow meters, one measuring steam to radiators on the 1st to 16th floors, the other steam to the 17th to 70th floors. These 2-pipe systems serve 179,000 sq.ft. of equivalent direct radiation. Radiators are of the inclosed Murray type with Direct Control thermostatic valves. Returns collect in the basement in a receiving tank, then are discharged by Nash vacuum pumps through hot-water preheaters to a cooling tank and sewer. Each up-and-down feed riser has an air-operated valve controlled by a master air valve. There are sixteen master air valves, one for each side of the building for the 1-16, 17-30, 31-60 and 61-top floors. This zone control makes it possible to obtain minimum steam consumption also on nights, Sundays and holidays.

To derive the curve of steam flow for various outside temperatures, the heat loss in B.t.u. per hr. per deg. difference in temperature was first determined, using the number of air changes per hour and the wall, glass and roof areas with their proper heat transfer co-efficients. In estimating these figures, particular attention was given to the amount of exposure, flue action, nature of tenants, and type of wall and building construction. B.t.u. per hr. per deg. difference in temperature was then converted to lb. of steam per hr. per deg. difference by dividing by 970. Results for the two zones corresponding to the flow meters were 250 lb. of steam per hr. per deg. difference in temperature for the 1st-16th floors, and 278 lb. of steam per hr. per deg. difference in temperature for the 17th-70th floors. From these figures, two charts, one of which is shown, were prepared.



The solid line indicates the actual flow of steam through the flow meter. Dash lines indicate the flow-meter reading required for various pressures on the upstream side of the flow-meter orifice for any given actual flow. With an outside temperature of 30 deg., actual steam flow required to heat the 1st-16th floors is determined from the figure by intersection of the 30-deg. line with the solid line as 10,000 lb. of steam per hr. With a steam pressure of 40 lb. ahead of the meter orifice, the flow-meter reading, to obtain a flow of 10,000 lb. per hr., is found by intersection of the 30-deg. line with the dotted line labeled 40 lb., and indicates that the meter should read 12,800 lb. per hr. Similarly, the flow of steam required for heating the 17th to 70th floors may be determined from the chart for the flow meter serving these floors.

These charts are then given to the heating system operator with instructions to vary the setting of the reducing valves until the flow indicated by the steam flow meters corresponds with the flow shown for the existing outside temperature. Outside temperature and flow-meter readings were checked about every 15 min. to guard against any sudden temperature change.

When this system first was used in December, 1932, temperatures throughout the building were watched to make sure that steam supplied according to these estimated figures resulted in satisfactory heating. During windy weather it was found necessary to increase steam flow slightly above that shown by the chart for the existing outside temperature in order to maintain satisfactory building temperatures. Under all normal weather condi-

tions, however, the estimated steam flow was found to produce satisfactory heating.

During the 1931-32 heating season, there were 4,396 deg.-days and 50,758,000 lb. of steam were consumed in heating the building. This resulted in 11,550 lb. of steam per deg.-day, or 0.826 lb. of steam per deg.-day per 1,000 cu.ft. of building volume.

In the 1932-33 season, there were 4,734 deg.-days, but the steam consumption for heating the building was only 42,971,000 lb. Steam consumption for deg.-day was reduced to 9,100 lb., and steam consumption per deg.-day per 1,000 cu.ft. dropped to 0.647. Considering that this method of operation was not put into effect until about the middle of the heating season, results were very gratifying. A still greater saving is confidently expected during the present heating season.

COMBINATION SYSTEM

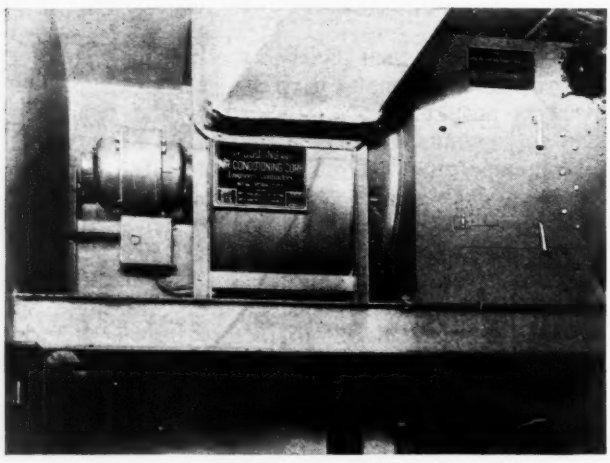
COOLS BIRMINGHAM STORE

A COMBINATION of the best points of unit and central control systems is used in the air-conditioning installation in the new Burger-Phillips Department Store, Birmingham, Ala. A central refrigerating system provides cold water for all units through a system of return and supply piping, but each unit is an air-cooling plant within itself, as it has an independent system of supply, return and fresh air make-up ducts. The installation incorporates the economy of the central control system, yet has the compactness and flexibility of operation and installation inherent in the unit system.

The cooling system was installed at a cost of $30,000. It involves eight units, two units for each of the first three floors of the main six-story building and one for each of two stories of the annex. Units are hidden in stock rooms, toilet rooms, etc.

Each cooling unit consists of silent-vane fan with wheel mounted on an extended motor shaft. Motors are ball bearing and spring mounted to minimize vibration. Canvas joints also prevent vibration. Cooling units are concealed in sheet-metal cases; each consists of two chambers between which are cooling coils of the fin-tube type. An electric thermostat in the fan intake directs recirculated air in proper proportions. An electric hygrostat in each unit controls an electric water valve in the supply line, which in turn regulates the amount of cold water circulated through the coils. Air from the outside passes through a dry-type filter.

Typical conditioning unit in a stock room



Refrigerating equipment includes one 80-ton vertical, single-acting semi-enclosed type compressor, arranged for short-center V-belt drive by a 100-hp. slip-ring motor, wound for 3-phase, 60-cycle, 208-volt current. Chilled water is circulated at 38 to 40 deg. F.

The forced-draft cooling tower on top of the annex includes two propeller-type fans connected to a squirrel-cage induction type weatherproof motor by V-belts and a centrifugal pump operating at 3,600 r.p.m. A double-suction, bronze-fitted centrifugal pump circulates water to and from the eight cooling units.

The installation is designed to furnish from 10 to 12 cu.ft. of fresh air per min. per person. This provision necessarily takes into consideration heat generated inside the building from light wattage and human bodies as well as heat infiltration. The units also vary in capacity, those on the first floor, for instance, being able to take care of larger crowds and more light wattage.

Fresh-air ducts are all concealed behind furred walls, except on the second-floor annex occupied by the beauty shop. Air is discharged into sales rooms near the ceiling through tapered, high-velocity nozzles with grilles and with such spacing as to give distribution of air currents. Recirculating grilles are near the floor.

The installation is guaranteed to cool the floors served to a dry-bulb temperature of 80 deg. and a wet-bulb temperature of 67 deg. when the outside temperatures are 95 deg. dry bulb and 78 deg. wet bulb. Operation during the cold season is not contemplated, but the system may be used for ventilation.

Operation of the air-cooling units increased the bill for electricity during the summer by $250 to $300 per month. This expense dropped to $100 to $150 per month at the end of the summer when the conditioning units were used only for ventilation. Average cost of power for air conditioning during 12 months is estimated at $200 per month.

The building superintendent puts about one-third of his time on operation and maintenance of the system. His salary is $150 a month, so the labor chargeable to air conditioning is $50 a month. The superintendent finds it necessary to test daily for leaks of refrigerant (Freon) and to tighten bearings and joints to prevent its loss, which has cost $10 a month. No other repairs have been necessary, and the larger part of his time is spent in watching operation.

The company has a 10-year lease on its present building, so that the equipment is being depreciated at the rate of 10 per cent a year. Thus the total cost of air conditioning, including operating and fixed charges, amounts to $660 a month.

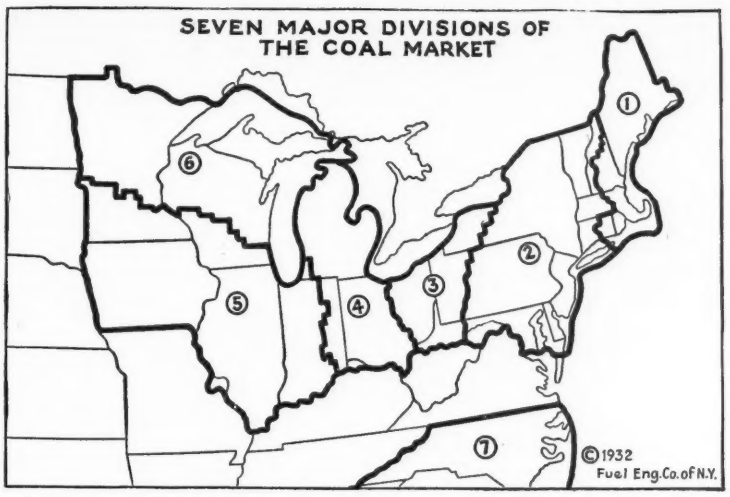
THE COVER—Six customers are served by this heating plant of Chicago Union Station Co., including the station itself and the new Chicago Post Office. Steam at 200 lb. pressure is generated by four 130,000-lb. capacity boilers equipped with waterwalls, economizers and turbine-driven chain-grate stokers. Other features include automatic combustion control and a dust-collecting system.

Photograph by Charles Phelps Cushing

CODE SHUFFLES COAL VALUES

An Interview with G. B. GOULD

President, Fuel Engineering Company of New York



Provinces 1, 4 and 6 produce no coal. Province 2 produces most of the coal it uses, but imports from Province 3, which supplies all its own needs and has a surplus that goes by water to Provinces 4, 5 and 6. Province 4 secures nearly all of its industrial coal from Southern West Virginia and Eastern Kentucky, which fields also ship substantial quantities into Province 5, in competition with coal locally produced there.

One Subdivisional Code Authority governs the coal that is used in Province 1. Another sets prices for most of the coal used in Province 2. Three other authorities set prices for the coal produced and used in Province 3. A sixth Code Authority sets prices for the coal used mainly in Province 4. Three more authorities set the price for coal produced in Province 5.

Will the Bituminous Coal Code, signed Oct. 2, affect readers of POWER who buy coal?

Yes, very much. It has already affected them.

In general, how?

The cost of bituminous coal for industrial purposes at points of consumption has increased 15 to 30%, depending upon kind of coal and location. In all coal fields, except Illinois, it amounts to from 50 cents to a dollar a ton.

This increase applies only to new contracts made since the code went into effect?

No. The most important increase has been on new contracts, but nearly all existing contracts contain clauses which permit increases in price to compensate for increases in wages or in cost due to Federal or State legislation.

Do increases in price under old contracts bring these prices up to the level of new contracts?

Generally not. Let me give you an example: Under an old contract, one of our clients was buying coal for $1.15 f.o.b. mine. He woke up with a shock one day to find that, in spite of this contract, he must now pay $1.65. But even with this increase he was getting better values than he would under a new contract at Code prices.

Am I to understand, then, that it will pay any buyer operating under an old contract to stick to that contract rather than shift to a new?

Not necessarily; it all depends upon the level at which the original contract started. In general, for a given mine, the wage adjustment results in a flat increase of, say, 40, 50 or 60 cents over the original contract price, whatever it was, for *all* existing contracts for that coal. If the original contract price was substantially higher than the market bottom, the flat differential added may raise it to a point where it will pay to look elsewhere for a new contract.

What is the general set-up for determining coal prices?

Look at the above map, prepared before the Code went into effect. This breaks down primary United States industrial areas into seven natural *coal-consuming* "provinces," arbitrarily numbered 1 to 7. Only the upper limits of Province 7 are shown. This province includes the southern industrial area, mainly North and South Carolina. Within each province the mass of buying has been limited by such economic factors as location and freight rate, mainly to coals from certain regions. Region 1, for example, confines its coal buying (eliminating hard coal) mainly to coals produced in southern West Virginia.

How many Code Authorities are there to determine the prices of coal?

Nine different Code Authorities determine the price of coals consumed within the seven provinces indicated. Several others cover outlying coal fields. You can see how complicated the set-up is when you realize that each principal Code Authority is setting prices independently of the other eight.

Help! What are they going to do with a situation like that?

Who knows?

How does the Code Authority of a sub-division determine coal prices?

There is no established method; details are left to each Code Authority. Broadly speaking, three different methods have been used. In the southern West Virginia low-volatile fields, coals are grouped into four quality classes by ash percentage. Each class is subdivided into three divisions according to fusing point, making 12 prices for any one size. These 12 base prices are then adjusted for a whole range of coal sizes.

Under the northern West Virginia sub-divisional Code Authority, mines are classed according to the *seam* mined. All mines operating in the same seam have the same minimum price, regardless of differences in quality.

The third method is illustrated by the Eastern Sub-divisional Code Authority price system. This includes chiefly low- and medium-volatile coals produced in Pennsylvania, Maryland and a portion of northern West Virginia. In this area is found a far greater variety of combinations of coal qualities than anywhere else. Yet, it was necessary to establish *some* method of setting minimum prices to comply with the Code, and each of the several hundred mines in this division has been assigned to one of 11 price groups.

This is pretty complicated. How can the buyer find out what any particular coal will cost?

As a practical matter, the buyer must get the price in each case from the man who sells the given coal.

You indicated a little way back that the Codes were definitely raising the prices of all coals on both old and new contracts. Power plants therefore definitely face an increase in steam cost. What can the individual coal buyer do? Isn't it simply a case of his coal costing more and that's all there is to it?

Not simply. Here's an example: In March, 1933, Coal "A" delivered to a certain client in a certain district cost him $3.91 per ton. Coal "B" at the same time had a delivered cost of $3.66. Putting both coals on a B.t.u. basis for comparison, the first cost $4.05 (for 30,000,000 B.t.u.) and the second $3.81. Thus, both coals being equally usable and efficient in the given plant, Coal "B" was a better buy in March, 1933, Then the Code came along, changing the delivered cost per 30,000,000 B.t.u. to $4.40 for Coal "A" and $4.85 for Coal "B." Now, Coal "A" is the better buy.

Then the coal buyer still has the problem of picking out his own best buy from an almost infinite number of possibilities?

Yes, as always, but in a complete new set of market values, plus further unpredictable changes.

Aside from points brought out, what, in a very general way, can the coal buyer look forward to?

Lord only knows! It is practically impossible to look forward six or eight months with any certainty, when price relationships are no longer governed directly by natural market forces, but instead by a highly artificial system of price fixing. One thing is certain, each coal buyer must immediately start the reappraisal of his entire local coal situation. He may penalize plant steam costs very seriously if he allows coal-buying habits of long standing to dictate his course during the months immediately ahead.

ENGLAND PROPOSES 1,224,000-HP. Tide-Power Plant

15- to 50-ft. tides at the mouth of the Severn River may be used in proposed hydro development favorably reported after a 7-year study

By H. E. M. KENSIT
Engineer, Ottawa, Canada

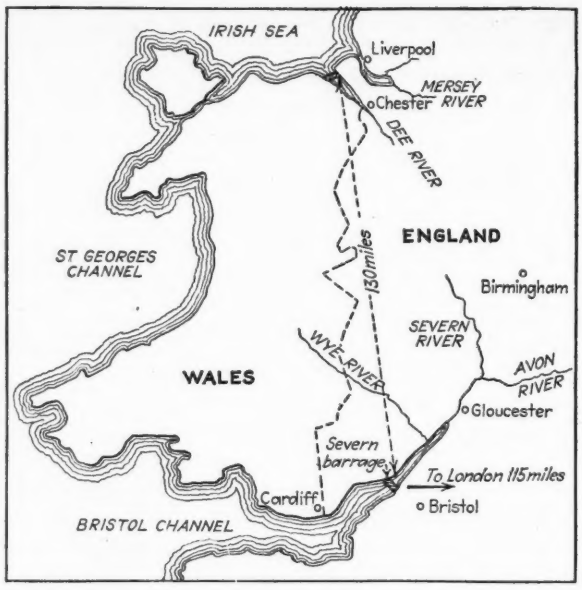


Fig. 1—Map showing location of proposed tidal-power projects on the Severn and the Dee estuaries

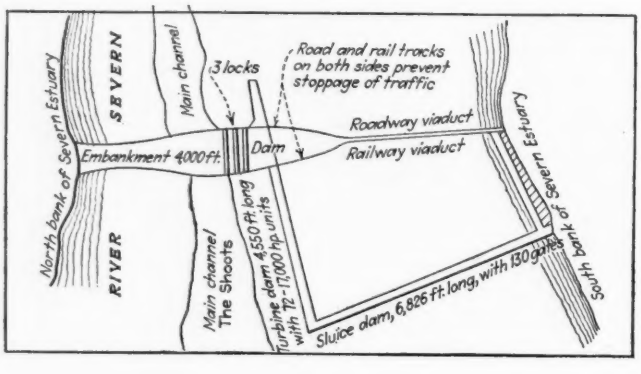
SITES for large tide-power developments are found in various parts of the world, but that at the mouth of England's Severn River has probably been given the most exhaustive study. Known as the Severn Barrage, it is the one most likely to be developed in Great Britain.

Previous to 1925, several engineering reports were made on the project, most of them favorable. In October of that year the Economic Advisory Council appointed the Severn Barrage Committee to study and report. After seven years of continuous work, the committee issued its final report early this year. Because of its thoroughness and consideration of economic as well as engineering aspects, this report will be welcomed by engineers.

Fig. 1 shows the location of the proposed project, Fig. 2 a general plan of the development. An important consideration is the urgent need for direct highway and railroad facilities between the highly industrialized districts on each side of the lower Severn. This need led to the first conception of the plan.

The complete project involves two power stations, one at the barrage to utilize the tides directly and one, a high-head, pumped-storage development, on the River Wye about 10 mi. north. As is well known, development of tidal power does not usually involve insurmountable engineering difficulties but is handicapped by high cost. In this case the committee has carefully weighed the economic considerations and compared the power cost with that of fuel station of equivalent capacity. The committee reached the conclusion that the tidal-power station alone could not compete with a steam plant, but with the addition of the storage hydro plant on the Wye could produce continuous power at two-thirds the cost of that from fuel.

Fig. 2—General plan of proposed Severn tidal-power project


SEVERN
Main channel
13 locks
Road and rail tracks on both sides prevent stoppage of traffic
Roadway viaduct
Railway viaduct
Embankment 4,000 ft.
Dam
North bank of Severn Estuary
RIVER
Main channel The Shoots
Turbine dam 4,550 ft. long with 72-17,000 hp. units
Sluice dam, 6,826 ft. long, with 130 gates
South bank of Severn Estuary

The tides in the Severn range from 50 to 15 ft. This is said to be exceeded at only two places in the world—at the Bay of Fundy in Canada and at the Canton River in China. The amount of water passing up the Severn above the barrage site under natural conditions is estimated to be about 24.5 billion cu.-ft. per tide at mean spring tides. The ordinary rise at spring tides is 40 ft. and at neap tides 22 ft. The head under which it is expected to work the turbines is from 32 to 5 ft. The rate of head change may be as much as 10 ft. per hr. Through the turbines the discharge will be from 400,000 to 580,000 sec.-ft.

Of the seventy-two 17,000-hp. turbines to be installed in the dam, Fig. 2, it is expected that 67 may be operated at one time. These will give the plant a maximum capacity of 1,224,000 hp. and a maximum operating capacity of 1,139,000 hp. Part of this power will be used for pumping water to the secondary storage on the Wye River. It is expected that a total of 2,252,000,000 kw.-hr. will be generated per year.

A 50-ft. model of the estuary was erected in Manchester University, complete with sandbanks and machinery to displace the water exactly as by the tides. This model was kept under scientific observation day and night for five years to obtain information on the effect of navigation, the best type of barrage, and to check the amount of power that could be generated. The report of Prof. A. H. Gibson on this model will be published shortly by His Majesty's Stationery Office, Kingsway, London W.C.2.

The type of barrage determined on is shown in Fig. 2. It will be seen that in order to provide the great length necessary to accommodate 72 turbines and 130 40-ft.

openings for sluices a V-shaped structure is proposed. The total length of dam is nearly 3 mi., the width of the river being about 2.25 mi. The barrage will contain three locks, with road and rail connections at both ends. Excellent rock foundation is available.

Secondary-Storage System

The River Wye flows into the Severn about 2.5 mi. above the proposed barrage. About 8.5 mi. up the Wye is the site for a storage reservoir of 1,431,000,000-cu.ft. capacity that will give an effective head of 440 ft. The tide flows up the Wye to this site, and here it is proposed to install a pumping and power-generating plant. The motors that drive the pumps will operate as generators when the stored water is discharged to the lower level. Part of the energy generated at the tidal plant would be delivered direct to the national power-transmission system and the balance available at any time would be used to pump water. The stored water would be used to carry the load when the tidal plant cannot operate. It is estimated that the storage plant would supply 845,000,000 kw.-hr. per year and the tidal plant would supply 798,000,000 kw.-hr. directly to the power system. This is a total of 1,643,000,000 kw.-hr. per year, or 74.5 per cent of the total energy that can be generated at the tidal plant.

The barrage across the estuary would create a roadway between important industrial districts, cutting off 50 mi. from the present route, and it would about quadruple the railway facilities now furnished by the Severn tunnel. It would benefit navigation and provide improved harbor and dock facilities.

The Costs

The committee believes that the capital for the project can be obtained under government guarantee at 3½ per cent, but allows 4 per cent. It is assumed that the railway, road and harbor interests would provide the portion of the total costs allocated to them. The costs as given by the committee, expressed at par of exchange, are:

Barrage and power station	$123,800,000
Reservoir and storage station	55,750,000
Extra transmission lines	7,300,000
Total power cost	186,850,000
Road, rail and harbor facilities	59,800,000
Total cost of project	$246,650,000

It is estimated that the necessary negotiations and obtaining of legal powers would take till 1937 and that 15 years would be required to complete the work. The total cost per kilowatt-hour delivered to the line is estimated at 0.4744c. This has to compete with fuel power, and it is estimated that the cost at the Battersea power station will be 0.6c., which leaves a margin of 21 per cent in favor of the tidal project.

River Dee Project

J. O. Boving in the *Times Engineering Supplement*, November, 1918, published an interesting study of the tidal-power possibilities of the River Dee, near Liverpool, Fig. 1. He pointed out that the great egg-shaped estuary of this river, with an area of 44 sq.mi. and tides ranging from 35 to 13 ft. could be divided by a dam on its greatest diameter, at right angles to the sea. The power station would be installed in the dam, and thus form, with the sea, three reservoirs. These could be so worked as to give practically continuous power. This site it was estimated could furnish about twice the power obtainable from the proposed Severn development. On the other hand, if the Dee were developed as a simple two-basin site at the same time as the Severn, the combination could be operated advantageously. These sites are about 130 mi. apart by air-line overland, but about 900 mi. by the irregular line round the coast of Wales. There is a difference of about 3.5 hr. between the tides at the respective sites. Therefore, if the two stations were electrically connected in parallel they could together furnish nearly continuous power.

Subsequently, it was claimed by other investigators that taking similar advantage of the difference of time in tides, developments could be made not only on the Severn and the Dee, but also on the Mersey, at Menai Straits and other points. If all were connected in parallel, they would provide, it was estimated, approximately 5.5 million continuous horsepower.

REPORT COMPARES METHODS OF STOKER COAL SUPPLY

A SURVEY of methods employed for supplying coal to stoker hoppers is included in the Prime Movers Committee report on Stoker Equipment and Furnaces, published by Edison Electric Institute. Twelve companies report the advantages and disadvantages of the various methods in use.

Seven companies use weigh larries for distributing coal from overhead bunkers to the stoker hoppers. This method of distributing coal permits certain latitude in location of stoker bunkers and permits coal to be taken for any boiler from any part of the bunker. Their use results in a light and well-ventilated boiler room, but most companies reported that larries cause considerable dust in the boiler room. One company stated that the accuracy of coal feed to each boiler, obtained by their use, was more important than the dust which they cause. Two companies discontinued the use of weigh larries and installed gravity-feed chutes. This, they report, has resulted in cleaner boiler rooms, less labor and elimination of noise and maintenance.

Two companies report the use of swimming coal spouts, moved by hydraulic cylinders supplied with oil from stoker-driven pumps. This type of feed, it is reported, prevents trouble from stratification of coarse and fine coal in the stoker hopper. It is also said to aid somewhat in boiler cleanliness and not to interfere with maintenance work on portions of the boiler directly behind it.

One company reported changing from gravity feed through spreaders with deflector plates to weigh larries. This was done because of a large number of bunker fires which it was thought were caused by the chimney action of the coal spouts. Since the changeover, there has been very little trouble from heating of coal in the overhead bunkers.

In one plant where spreaders are used, the company reports having tightly jointed the coal chutes to the stoker hoppers to minimize the coal dust loss to the boiler room. All spreader and extension hopper joints are welded and access doors made dust-proof by gaskets. Access is obtained through individual doors and portholes installed so that there is no spillage of coal when they are opened. The measures are reported as very effective in maintaining cleanliness.

20 WAYS TO CUT POWER COSTS

IN THE PLANT DISTRIBUTION SYSTEM

1. Improve Maintenance
2. Improve Operation
3. Shut Down Idle Machines
4. Keep Driven Machines Repaired
5. Align Shafting
6. Improve Power Factor
7. Eliminate Overmotoring
8. Replace Slow-speed Motors with High-speed
9. Use Multi-speed Geared Motors
10. Install Group Drives
11. Install Fynn Weichsel Motors
12. Install Synchronous Motors
13. Replace Old Motors with New
14. Increase Power Line Size
15. Obtain Better Power Rates
16. Equalize Production
17. Do Not Increase Load at End of Month
18. Improve Load Factor
19. Increase Night Load
20. Eliminate Peak Loads

POWER costs may be reduced in two general ways: improvements inside the generating plant, and improvements outside. Here we consider only the latter—that is, after power is delivered to the load switchboard whether purchased from a utility or generated in an isolated plant. The fact that purchased power costs have been reduced as much as 33 per cent by improved maintanence and operation emphasizes the importance of giving careful attention to this problem.

All plans for reducing power costs must be predicated on proper maintenance and operation of equipment. Large power losses can result from poor insulation, machines running unnecessarily, equipment in poor condition (such as leaky valves in reciprocating pumps and compressors, and worn seals in centrifugal pumps). Leaky water and air lines and extravagant use of these services frequently cause large unnecessary power consumption. Equipment and shafting out of alignment and tight belts are other causes of power losses. The friction load of some equipment increases rapidly with bearing wear.

Conditions in plants vary, but the foregoing indicates some of the ways in which adequate maintenance will reduce power costs. In addition to cutting power costs, production costs will be reduced, and in some cases product improved, because of increased power-equipment reliability. All of this can be attained from little or no investment. Besides, maintenance cost will be reduced. The cost of properly maintaining a plant is always less than making repairs only when something happens.

Where power is purchased, low power factor is frequently the cause of increased power costs. A typical power-factor clause in power rates decreases the monthly power bill 0.5 per cent for each 1 per cent the power factor is above 85 per cent and increases the bill by the same amount for each 1 per cent the power factor is below 85 per cent. With this rate the power cost is 19 per cent more at 65 per cent power factor than at unity.

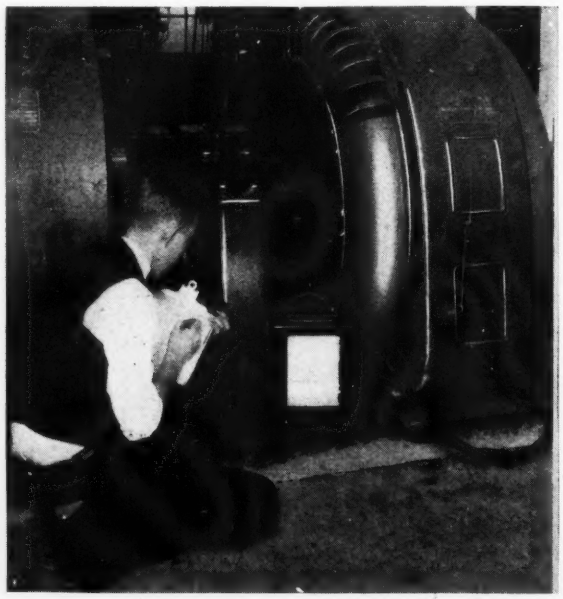


Fig. 1—Unloaded motors are a frequent cause of low power factor which should be determined by a load survey with meters

Using oversize induction motors is a frequent cause of low power factor. Therefore, in a power-factor correction program the first step should be a survey of how motors are loaded, made by portable metering equipment, Fig. 1. Considerable improvement in power factor and motor efficiency has been made in some cases by regrouping motors. For example, a 5-hp. motor may be used to replace a 7.5-hp. motor and the 7.5-hp. motor be installed to replace a 10- or a 15-hp. machine. Frequently, slow-speed motors are installed where a high-speed motor, connected to the load by a belt, chain or

gear, would be more economical and satisfactory in every way.

Slow-speed induction motors have a lower efficiency and power factor than high-speed motors. At half load, the slow-speed motor's power factor may be 20 per cent or more less than that of the high-speed motor. When an underloaded slow-speed motor can be replaced by a smaller high-speed motor with a speed reducer, the power factor of the drive may be increased 20 per cent or more and the efficiency materially improved.

A simple, high-speed, squirrel-cage motor with a multiple-speed gear may operate at a considerably higher power factor and efficiency than a multi-speed motor or even a wound-rotor motor. The economies of multi-speed, geared, squirrel-cage motors, particularly in the small and medium ratings, should be considered where multi-speed will serve the application requirements.

A large number of small squirrel-cage motors on individual drives is frequently the cause of low power factor, and a cause difficult to correct. If the motors are not too small, some of them may be replaced with Fynn-Weichsel type motors to bring the power factor of the group within an economic value. An alternative is to eliminate the individual motors and install modern group drive with a single large motor, Fig. 2. Because of the better load factor of the group, a motor can be used that is considerably smaller than the sum of the horsepower ratings of the individual motors, and will operate at a higher efficiency and power factor. In some cases, group power requirements will be large enough to permit use of a synchronous motor.

Many plants, particularly in the heavy industries, offer a wide variety of applications where synchronous motors are the most desirable type of drive. These motors operate at a constant speed, fixed by the frequency of the power circuit and number of poles in the motor. They are designed in two general types, one that at full load normally operates at unity power factor and the other designed to have 80 per cent leading power factor at full load. If the desired system power factor can be obtained with unity-power-factor motors they should be used, as they have a higher efficiency than 80 per cent power factor type. In sizes above 100 hp., synchronous motors are preferable to induction motors for many applications. They have a higher efficiency and their power factor can be controlled and normally is unity or leading during operation.

Improving the power factor of the system may not only reduce power costs by a direct reduction in the rate, but may also decrease the losses in the lines and other service equipment. For example, copper losses at unity power factor are about half of what they are at 70 per cent power factor, equal power being transmitted. In other words, if at 70 per cent power factor the copper losses are 10 per cent, a 5 per cent saving in power can be made by improving the power factor to unity.

Improved voltage regulation will decrease current taken by motors and will further reduce power losses. A higher and more constant voltage at power terminals may not only increase production, but also improve its quality. Where voltage is less than 90 per cent of normal, the increase in current may roast out motors if they are operating near full load at normal voltage.

Where sufficient power-factor correction cannot be obtained by rearranging the motors or by the installation of synchronous motors, then capacitors may be installed. These devices are simple in construction, are reliable, have very low losses and require a minimum of attention.

Power-factor correction is a primary step in saving power dollars and involves many problems which cannot even be outlined here, for lack of space.

Synchronous motors in the larger sizes of 200 hp. and above will have an efficiency of from 1 to 5 per cent higher than induction motors of equal horsepower and speed. This saving, added to that obtained from improved power factor, generally makes synchronous motors attractive economically.

Where motors are of old designs, the saving in power and other items that can be made by changing to modern

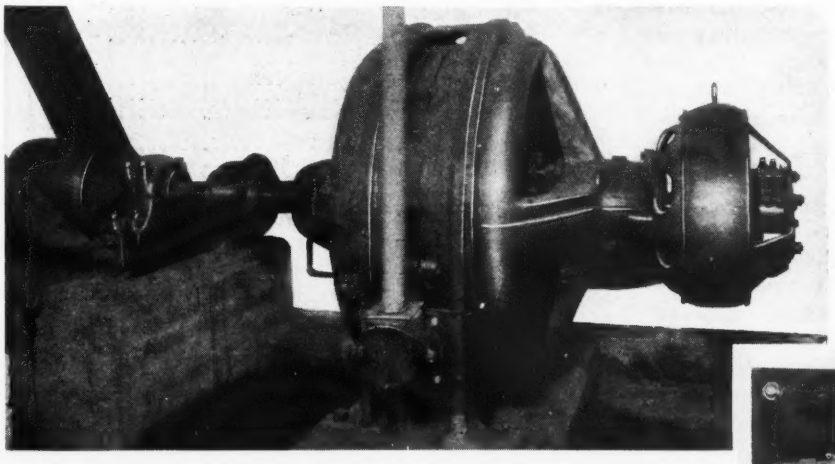
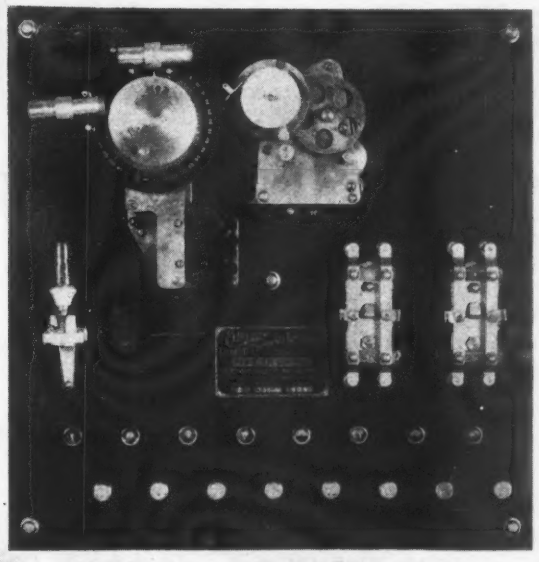


Fig. 2—A 200-hp. synchronous motor coupled to line shaft of group drive improves efficiency and power factor

Fig. 3—Power demand Limitator automatically controls peak loads within a predetermined limit



motors frequently justifies the replacement cost. Modern motors have an efficiency from 5 to 10 per cent higher than old types, depending upon their size and how nearly they are loaded. Feeders are frequently overloaded, and increasing their size will not only decrease power costs but improve operation.

When power is purchased, study of power rates frequently will show how large savings in cost can be made. Sometimes a better rate schedule can be had. However, the most likely plan to cut power costs, by improving the rate, is to keep down the demand charge by reducing peak loads. This can be done in several ways. The first is by giving attention to production schedules to improve load factor.

Frequently production is allowed to lag during the early part of the month and rushed during the latter part, producing unnecessarily high power peaks. The cure is obvious; when new load is to be added, care should be taken to avoid doing this near the end of the month. If a 1,000-kw. furnace is added on the last day of the month, the peak load and power cost may be increased by that much. Cases are on record where the power cost in a given month have been increased $1,000 or more by adding load near the end of a month that could have been held off until the succeeding month.

In many instances it is possible to take care of certain operations at night and thus keep down the day peaks. For example, where heat-treating and baking are done in electrical furnaces, if these furnaces are operated at night during off-peak periods, peak load can be materially reduced.

High peak loads may occur only a few times a month. In many plants there is equipment that can be disconnected for the short period necessary to avoid these peaks. For example, air compressors, pumps and furnaces frequently can be disconnected for a few minutes at a time without interfering with other operations. Automatic means, Fig. 3, are available for maintaining load peaks within predetermined limits. The equipment disconnects certain parts of the load, such as air compressors, when the peak approaches the established limit and connects the load again when the peak has passed. This feature of cutting power costs was given comprehensive treatment in an article "Reducing Peak Loads Cuts Power Costs" by Edward T. Moore, page 476, September *Power*.

The problem of reducing power costs has many ramifications, as the foregoing will indicate. In most plants a little intelligent investigation will show opportunities for cutting these costs by some of the means suggested. Frequently savings can be made by a little attention to operating details at little or no investment.

GASOLINE-ENGINE GENERATOR SET USES WASTE HEAT

TAKING his own medicine to save money, the Chevrolet agent in Lincoln Park, N. J., has evolved an unusual gasoline-electric generating set which also includes a waste-heat utilization scheme. The agency includes a showroom with exterior floodlighting, garage, 7-room apartment and a separate machine shop, total electrical consumption being about 1,500 kw.-hr. per month.

About the only product wasted is engine noise. A Chevrolet engine and a 12½-kw. "Bell" alternator, mounted on a channel base with direct-connected exciter, form the plant. The warm jacket water is circulated through a unit heating the machine shop (a separate building), exhaust manifold heat warms the showroom through an air blower and duct system, and a water jacket on the exhaust pipe provides hot water in a small 30-gal. storage tank. A simple switch panel with pilot light, field rheostat and voltmeter completes the installation.

The engine runs at a speed approximating that required to drive an automobile 43 miles per hour. Investment costs on the engine-generator set alone approximated $600, and gas and oil costs ran 2 cents per kw.-hr. with 10-cent (wholesale price) gasoline.

Output is 1,500-kw.-hr. per month, plus 5-hr. heating for buildings, with 5-hr. operation each day. A small oil burning boiler provides heat and hot water during the time the engine is idle.

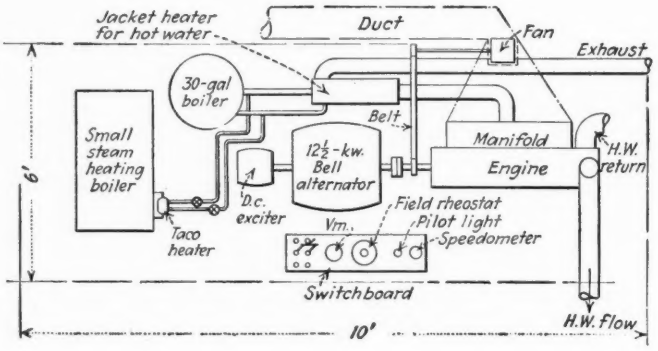
Tabulated comparison of costs gives these data:

	Per Month
Investment—$800@6%	$4.00
Gasoline—250 gal.@10c.	25.00
Oil—3 gal.@50c.	1.50
Maintenance—Estimated $50 per year	4.00
Depreciation—@20% per year	13.00
Space	0.50
Standby charge	5.00
Attendance—none	
Total	$53.00
Value of by-product heat	
Reduction in oil consumption, 1,000 gal.@5c. is $50, or, per month	$4.00
Net Cost of Operation, average	$49.00
Cost of Purchased Power	
225 kw.-hr.@10½c.	$23.63
600 kw.-hr.@6c.	36.00
675 kw.-hr.@3c.	20.25
1,500 kw.-hr. average 5.3c	$79.88

Net Saving per Month = $79.88 — $49 = $30.88

The installation will pay for itself in 2 years at this rate. Several elements of the installation make it unique, including the unusually low fuel and lubricating oil cost. With usual retail charges, the saving would drop to about $15 per month. But even this is remarkable with a load factor so exceptionally low. Further, almost all equipment, except the engine, was purchased second-hand; consequently fixed charges are reduced enormously. Also, few localities have utility rates so high; usually "night rates" are available.

An interesting sidelight on the installation is the fact that it has actually operated for eleven months without repairs at a speed equivalent to 43 m.p.h.



PRACTICAL AIDS TO OPERATION

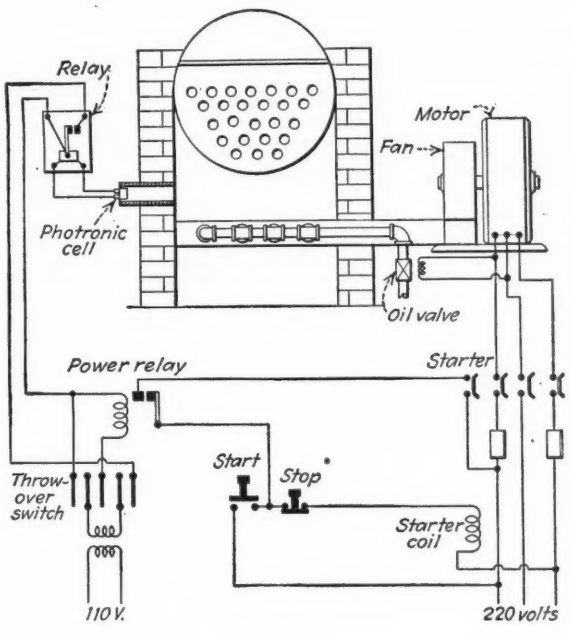


Photo-Electric Cell Protects Boilers

On oil, gas or pulverized-coal fired boilers, there is ever present the danger of an explosion should the fire go out accidentally without being known by the operators. In the Procter & Gamble Company plant at Cincinnati, O., the boilers are oil-fired and are protected by a photronic-type photo-electric cell against this danger. As shown in the diagram, the installation consists of a photo-electric cell mounted in a pipe reaching through the wall of the furnace so that the cell will be acted upon by the light from the fire. The cell is far enough away from the fire so that it will not be injured by heat.

A sensitive relay connects to the photo-electric cell and controls the circuit to a power relay. As long as the fire burns and the light strikes the cell, the sensitive relay is held closed to complete the circuit through the power-relay coil. The latter's contacts complete the circuit for holding the draft-fan-motor starter in the running position and for holding the fuel valve open.

If the fire happens to go out, the photo-electric cell functions to open the sensitive relay to shut down the draft fan and close the oil valve, hence there is no danger of oil accumulating in the hot furnace and causing an explosion.

New York City. John Allen Murphy

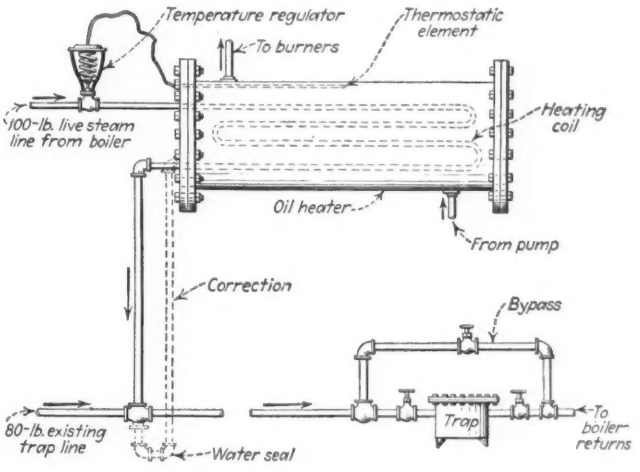
Steam Backs Up Into Heater and Causes High Temperature

Where high-pressure trap systems are installed, it is important that each individual condensate drain have its own trap. This is especially true if thermostatic control is in use. One interesting case may be mentioned that occurred in an oil-burning boiler plant some time ago. An oil heater was provided for the fuel oil between the oil pump and the burners. This received live steam from the boilers and was thermostatically controlled. The figure shows the general piping arrangement.

Condensate from the heating coil was piped into an existing trap line. As steam pressure in the trap line was about the same as that supplied to the coil, it was thought that satisfactory results would be had. The temperature regulating valve was set to close the steam supply when the oil temperature had reached 180 deg. F. and to open wide at 140 deg.

When this heater was first placed in operation, everything went fine while the steam pressure and corresponding temperature were low. When the boiler pressure increased to normal, it was noticed that the oil temperature was 200 deg. and still rising. An examination of the system showed the steam regulator valve to be seated but the temperature was still going up. Before the steam could be shut off from the entire system, the regulating valve stem was bent to the shape of the letter "S" and was damaged beyond repair.

A careful check showed the trouble to be in the trap line. The condensate would pass to the trap all right, but steam from the existing trap line had backed up into the discharge end of the coil, displacing the condensate which flowed back by gravity. This had caused a further increase in the oil temperature with the regulating valve already seated. The expansive element had finally bent



the brass valve stem, being unable to release itself in any other way.

Such an occurrence can be prevented in the future by two methods: first, by installing a separate trap for the heater; second, by piping the coil discharge line in the form of a syphon, as shown in dotted lines. The drop leg forms a pocket for condensate to prevent the steam from backing up as it had done before.

Cleveland, O. M. E. Wagner

Metering Steam to Reciprocating Engines

It is known that any flow-metering device installed in a pulsating flow will register a higher flow than the actual. An attempt to measure the steam flow to two

reciprocating engines resulted in readings practically valueless, as the degree of error varied with the load on the engines.

The meter was the orifice type with an electrical recording mechanism. The orifice was installed in a 12-in. pipe about 70 ft. from the nearest engine. A 10-in. pipe was connected between the 12-in. pipe and an 800-hp., 28x48, corliss engine running at 105 r.p.m. A 5-in. pipe was connected between the 12-in. line pipe and a 200-hp., 15x16, uniflow engine running at 265 r.p.m.

It was found on test that the large engine was the offender, as the meter gave accurate results when measuring the steam flow to the small engine alone. A large receiver was then installed in the 10-in. pipe line just above the corliss engine. The meter then registered the correct flow with both engines running, and checks a meter of the same type (within 2 per cent) located in the feed-water line to the boilers.

Memphis, Tenn. G. HOFFMAN

Reduced Water Flow Caused Trash Accumulation in Condenser

LAST winter a large power plant had an interesting experience with its condensing equipment for the turbines. One of the turbines was served by a single-pass condenser divided into an upper and lower deck. One circulating-water pump of about 30,000-g.p.m. capacity was provided for each deck of the condenser. The discharge valves on these pumps were normally in any position from one-half to wide open depending on the turbine load.

During a cold part of last winter, when the temperature of the circulating water was down to 32 deg. F., it was decided to throttle down the discharge valve on the circulating pump for the lower deck of the condenser until a very small quantity of water was flowing. This was done and no change in the vacuum was noticed at that time.

This idea worked fine for several days, when it was observed that the vacuum on the turbine had dropped from 28.65 to about 26 in. Inspection of steam-air jets, dry vacuum pumps and atmospheric valves failed to indicate any air leak, so the matter of cooling water was next given attention. The discharge valve on the bottom deck pump was opened a little more. The vacuum quickly went back to normal, but in a short time began to drop again. The valve was again opened a little more, with the same result.

The bottom deck of the condenser was then opened for inspection and it was discovered that with the circulating-water pump throttled, only part of the lower rows of tubes were being supplied with water. All the leaves, sticks and other refuse in the water that had got by the travelling screens had been concentrated on the several lower rows of tubes instead of being uniformly distributed over the entire tube sheet area. This had caused a cross-section of tubes to become fouled in a comparatively short time. While it is true that the water level would rise enough to flow through clean tubes, its velocity would be greatly reduced. Increasing the valve opening produced the same result. It was decided then that a saving on circulating water pump power was more than offset by the difficulty experienced.

Milford, N. J. HARRY M. SPRING.

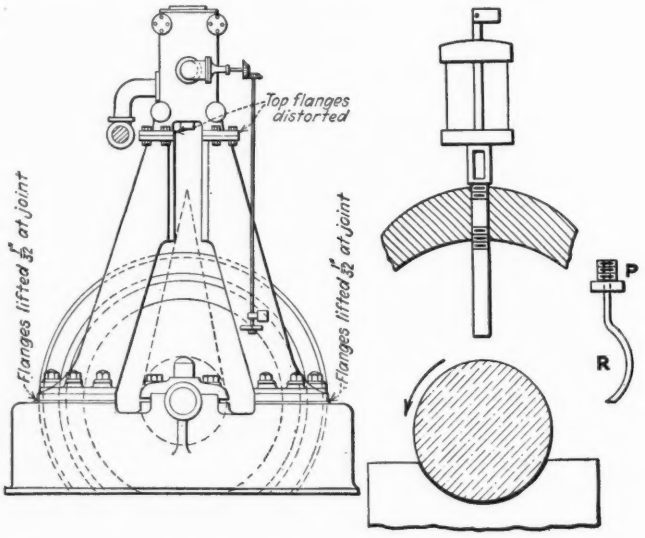
High-Temperature Steam Distorts Engine Cylinder

THE high-pressure cylinder of a 1,000-hp. vertical-compound engine was found to be distorted after a few years of service. This was caused by the high temperature of the steam, which is superheated to give a total temperature of 550 deg. F. The engine is of the usual vertical type with a central flywheel grooved for a rope drive. The cylinders are bolted to heavy square cast-iron columns resting on a box-type bed plate, as in the figure.

Trouble first was noticed at the bolts holding the columns to the bed plate. The outer flange bolts required attention and adjusting, as a slight lifting action occurred in the columns at these points. Checking the alignment of the high-pressure side showed that the top flanges of the columns and the cylinder feet could not be brought together properly. The distance between the cylinder feet centers was found to be about 1/16 in. less than it was when the engine was installed. There was also some distortion of the flanges on the feet.

The remedy for the trouble would have been to rebore the bolt holes and fit larger bolts, but as a temporary remedy the columns were bolted tight to the cylinder and the lack of alignment between the bottom flanges and bed plate was taken care of by shimming under the flanges. The cause of the trouble in this engine was that it was not designed for the high temperature, the superheaters being installed in the boilers several years after the engine went into service.

Blackburn, England. J. CASSIDY.



Change in Oil Feed Stopped Bearing Heating

ALTHOUGH provided with sight-feed cups in addition to the pressure line from the pump, the end crankshaft bearings of a 6-cyl. vertical engine ran hot, and required taking up twice as often as those between the cylinders. Oil from the lubricator was fed through sight feed, dropped through the ½-in. pipe, onto the top of the revolving shaft. By watching the drops of oil it was apparent that fully three-quarters of the lubricant fed either spattered or was thrown off the shaft without ever reaching the bearing.

At times the oil feed would stop entirely because the air carried around the shaft built up a pressure at the

lower end of the guide tube. The oil would eventually start to flow with a gush but with little or no relief to the overheated bearing.

By removing the feed pipe and substituting for it a brass plug *P*, drilled out and having sweated into it a length of ¼-in. copper tubing, the trouble was eliminated. The tube *R* was curved to bring the oil flow nearly tangential to the shaft surface in the direction of rotation. When so installed, it was found that the slight suction set up at the orifice did away with the intermittent air lock in the sight feed. The partial vacuum thus created insured a steady flow of lubricant with a finer adjustment than had previously been possible. The end of the tube was set so that it just cleared the shaft. Changing the oil lead to make sure that all the lubricant reached the shaft cured overheating of the bearing.

Longview, Texas — ELTON STERRETT

Boiler Pressure and Gas Temperature Drop Suddenly

A WATER-TUBE boiler having 4,250 sq.ft. of heating surface had been banked at night for two hours. The boiler-feed pump was shut down, and there was no steam generated by the boiler except that to make up pipe-line condensation. The flue-gas temperature recorder registered close to 430 deg. F. for an hour, and the recording steam-pressure gage was holding 135 lb.

The operator of a 100-hp. engine, failing to notify the fireman before, started up the engine. When the engine was started, the flue-gas temperature quickly dropped to 360 deg. F. and the steam pressure dropped to 105 lb., when the fireman opened the boiler damper and began to work up the fire.

The quick lowering of the flue-gas temperature, although there was no change in the amount of the gases passing through the boiler, has an interesting explanation. The steam temperature corresponding to 135-lb. pressure is 358 deg. The steam temperature corresponding to 105-lb. pressure is 341 deg. The drop in temperature of 17 deg. F. therefore accounts for only part of the sudden lowering of the flue-gas temperature. The rest of the drop can only be accounted for by a much more rapid absorption of heat by the water in the boiler from the flue gas. This in all probability resulted from the sudden expansion and liberation of the steam bubbles from the heating surfaces of the boiler, due to rapid reduction of the pressure, which caused an agitation or increased circulation of the water in the boiler.

Memphis, Tenn. — G. HOFFMAN

CURRENT COMMENT

Furnace Doors Used for Explosion Relief

C. O. SANDSTROM's comments on Mr. Spring's article "Obstructed Explosion Relief Doors Wreck Boiler Setting," expresses the experience of many engineers who have changed from coal to gas or fuel-oil firing. Everyone is familiar with the settings of the older types of horizontal return-tubular boilers, where a back plate of cast iron was placed next to the back head, so as to be easily removed for cleaning or renewing tubes. Later, cast-iron knees were used, spaced so as to lay fire brick as a cover.

When the first flush production of oil was reached in California, much of the oil was burned under boilers as it came from the wells, and it had just enough naphtha in it to be dangerous. It frequently happened that gas would accumulate before the fire was going well, and an explosion would result. With an iron-plate back on the boiler, the plate simply lifted and settled back into place, but with brick arches, they were usually scattered all over the boiler room.

A plate that lifts in a horizontal plane, I have found, gives more ready relief than if hinged at one side. If the relief doors can only be placed on the sides of the furnace, they must necessarily be hinged, but most boilers of any type have a flat surface somewhere at the top, where a horizontal plate can be installed. Distance from the fire chamber does not seem to make any difference, but losses from radiation are naturally less at a distance. The relief doors on the escape shaft of a coal mine are frequently a mile or more from the scene of an explosion, but they always act promptly.

St. Louis, Mo. — L. R. BAKER

Making Soot Blowing Easy

THE article "Making Soot Blowing Easy," page 516, October *Power*, was read with interest. I fully agree with Mr. Robinson that the man responsible for clean boiler tubes often neglects to do a proper job of it. This, however, as Mr. Robinson suggests is in most cases due to the operator's effort to avoid local disagreements.

There is one point in the article with which I take issue. It is stated that a plant operating eight boilers blows each soot-blowing drain line to atmosphere three minutes in warming up. This is certainly setting a high time limit to bleed this with the valve wide open. But, why use Grashof's formula in figuring the steam loss? This formula is for steam flow of constant density of approximately dry saturated quality. The specific volume and proportional density of the condensate followed by very wet steam of gradually increasing quality is very much different than that of dry saturated steam. It is a complicated calculation to integrate the total variance in flow with density varying from that of condensate to dry saturated steam. Once the quality of the warm-up steam approaches dryness—or nearly constant density where Grashof's formula might be applicable—there is certainly no need of bleeding the steam any longer. The system is then at very close to its highest temperature.

Although the inference of a distinct loss due to this practice is absolutely correct, the actual loss will be much less than the given estimate. The most practical method to check this loss is to run it through a temporary condensing coil and run the condensate into a weighing tank, closing the drain valve when the system is at its proper temperature.

Milford, N. J. — HARRY M. SPRING, JR.

Pipe Cutting and Threading Costs

CONSIDERABLE difference in opinion seems to exist as to the costs of cutting and threading pipe. Recent comment in *Power* shows to a degree the extent of this difference; each contributor assumes his figures to be correct. This wide difference in costs may be traced to the difference in the rate of pay in different localities and other local causes.

While reading these comments of readers, I have noticed that no figures have been given for a unit of work in a unit of time. It occurred to me that a better way of comparing costs may be had in this way.

One large industrial plant, having much pipe work, found it essential that they know their piping costs, so they undertook to figure the pipe-cutting and threading costs. They established a "unit of work in a unit of time" system that was successfully used. The cutting and threading of the pipe here were close operations, one succeeding the other; but there was a very distinct difference in the method of apportioning the time allowed for each operation.

The extra labor required previous to cutting the pipe was added to the actual time required for cutting and threading, using a standard charge determined by time study of actual conditions over a period of time which allowed for delays, such as changing dies, etc.

At the start of the system it was found that the time required for the actual cutting of the pipe varied; this was traced to the cutters becoming dull. To explain this point, it may be assumed that a $\frac{3}{4}$-in. pipe is to be cut with a sharp knife-blade cutter. The time allowed here was 20 sec. for cutting and 20 sec. for reaming, but when this knife cutter was dull cutting time remained the same but reaming time was increased to 40 sec. When a cutter of the wedge-wheel type was used, 25 sec. was required for cutting and 35 sec. was required for reaming. It was often necessary to cut a 2-in. pipe with hand tools. A 2-in. pipe required 45 sec. for cutting and 40 sec. for reaming with a sharp knife cutter, when this cutter was dull about 55 sec. was required for cutting and 70 sec. for reaming. A sharp wedge-wheel cutter on 2-in. pipe required about 70 sec. cutting time and 55 sec. reaming time. It will be seen from the comparative figures above that the cutters should be sharp and must be properly selected.

To keep the time required in man-hours down to a minimum, it was found necessary to locate the pipe stock in such a way that the length could be brought to the bench or machine with a minimum amount of labor.

The following figures are in cuts per hour and threads per hour:

Pipe Size	Cuts per hour	Threads per hour	Pipe Size	Cuts per hour	Threads per hour
$\frac{1}{4}$	14	37	$2\frac{1}{2}$	6	20
$\frac{3}{8}$	13	33	3	5	18
$\frac{1}{2}$	11	30	4	4	14
$\frac{5}{8}$	10	28	5	3	10
$\frac{3}{4}$	9	26	6	2.6	8
1	8	24	8	2	6
$1\frac{1}{4}$	7	18	10	1.5	4
$1\frac{1}{2}$	6	17	12	1.2	3.5
2	7	22	14	1	2.8

Cuts per hour above means the time required for actual cutting plus the subordinate labor needed.

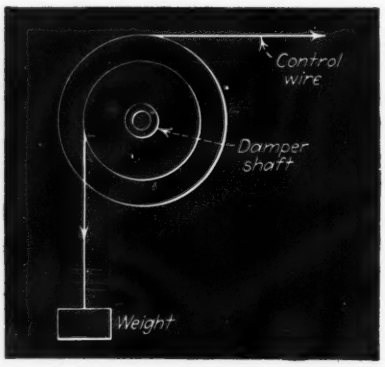
To explain the above figures, assume 60 pieces of 3-in. pipe are to be cut to size and threaded. To figure the time required: 60/5 = 12 hr. required for cutting and 120/18 = 6.7 hr. required for threading. There are times when but one cut per length is required. If the time here exceeds figures for cuts, it will be made up in threads, as but one thread has to be cut and two are allowed for.

Brooklyn, N. Y. WM. ANDERSON

Convenient Manual Control For Boiler Damper

I WISH to comment on the article "Convenient Manual Control for Boiler Damper" by M. E. Wagner in October *Power*. There is an objectionable feature to the method shown, for if the control wire should break, which is quite probable, the damper would be shut by the weight.

A better method would be to key two pulleys on the damper shaft, one pulley to be actuated by the control wire and the other by the weight rope, as in the diagram. With this arrangement the weight tends to open the damper and the control wire to close it. Then if the control wire breaks, the damper will be opened by the weight. Every operating engineer knows the uncomfortable results of sudden closing of a damper with a boiler under load, regardless of the fuel used.



Chicago, Ill. S. E. NICHOLS

Exhaust Gas Turbine Supplements Waste-Heat Boiler

WE HAVE read with much interest the article on "Diesel-fired Boilers" on pages 534-635 of October *Power*. One point, however, may lead to a wrong interpretation.

From the caption for the illustration on page 536 it must be concluded that an exhaust-gas turbine driven supercharging blower is an alternative to using the heat of the exhaust gases in boilers or water heaters. This impression is wrong. The exhaust-gas turbine, which drives a scavenging or supercharging blower (in connection with 2-cycle or 4-cycle diesel engines, respectively) does not extract from the exhaust gases such an amount of energy that it would no longer be possible or economical to utilize them after the turbine in a waste-heat boiler or water heater of any description. On the contrary, a considerable number of exhaust-gas turbine blower sets, supplied by Brown, Boveri & Co., are in operation, where the gases are so utilized after passing through the turbine. It thus appears that exhaust-gas, turbine-driven blower sets for supercharging according to the Buechi system or for scavenging do not exclude the installation of other waste-heat recuperating equipment, but form a valuable supplement to them. This, in fact, is operating with much success in a considerable number of plants.

New York, N. Y. PAUL R. SIDLER
Brown, Boveri & Co., Ltd.

Four New Uses for Engine Waste Heat

SUPPLEMENTING your articles on the various uses of exhaust gases and waste heat from diesel and gas engines, I take the liberty to mention the following uses which have been developed in Europe during the last few years in order to increase the over-all efficiency and economy of power plants.

Solid CO_2 is often made from the exhaust of gasoline engines and gas engines in the same manner as described in another combination by W. R. Kitzmiller in *Power,* June, page 296. You can regain 2.2 to 2.5 lb. of solid CO_2 per engine horsepower. It is simple to clean these exhaust gases, because the fuel gas is carefully purified before introducing it into the engines. However, the exhaust gases from *diesel* engines cannot be so efficiently used for this purpose, because it is more difficult to separate traces of fuel oil from diesel exhaust gases.

Another kind of chemical utilization is patented in Germany by Deutz Motor Company, Cologne—the direct drying and bleaching of cereals by the exhaust gases of gas engines. This bleaching the skin of cereals is very successful and without disadvantage to the taste and wholesomeness of the cereals. It is simply further conservation, as these exhaust gases contain the same bleaching ingredients as many artificial bleaching chemicals—small traces of SO_3.

In this direction lies also the utilization of the exhaust to serve as a safety gas to prevent explosions in gasoline tanks. Naturally, this gas must be cooled by water before using, but it is of interest to mention that there is a factory in Germany that has patents *not* to produce power from small 2-hp. gasoline engines, *but* to produce protective gas for gasoline tank stations, so that in this case the power is the by-product.

There is also a possibility of manufacturing ice from exhaust heat by the well-known absorption method, which is called "Cold by Heat." This is actually the second step in utilizing the waste heat, as it is also a second stage to produce reserve power from waste heat by waste-heat steam turbines. LUDWIG LUSTIG

New York, N. Y. *Engineer, Deutz-Motoren-Gesellschaft*

Reducing Valves

IN THE last paragraph of his article on page 423 of the August, 1933, number of *Power,* after confining his article and illustrations on pressure regulators entirely to double-seated valves, Mr. Bendel admits that the conventional double-seated valve won't hold a dead-end.

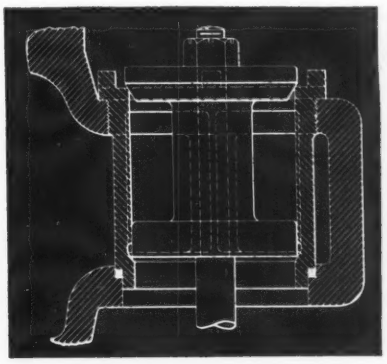
It is my contention that in modern practice there are few installations where, at some time or another, absolute dead-end is not required and that a valve that will not hold dead-end is *not* a pressure regulator.

I further contend that it is possible and practical to make a self-contained, pilot-operated, single-seat regulator, with metal diaphragms but without stuffing boxes, that will be application to practically all installations requiring pressure control and that accurate regulations can be obtained, regardless of fluctuations in the initial pressure or the flow of fluid through the main valve and that it will shut absolutely tight on a dead-end.

I further contend that it is possible and practical to furnish a seat and disk made of such materials that they are immune from the wire-drawing (cutting) action of steam and that such seats can be secured that will be guaranteed for at least five years.

I can see only one advantage in a double-seated valve. That is that it is cheaper to manufacture in large sizes where the size of the diaphragm in a single-seated valve becomes considerable. Therefore, if a double-seated valve is recommended for services where first cost is the primary consideration, that double-seated valve should be properly designed.

The drawing shows a double-seated valve where the two seats are carried in a separate removable cage. This cage is screwed into the body at the upper end and is free to expand against a resilient gasket at the lower end. The disk casting is made of the same materials as the cage, so the two are free to expand and contract together. If they are tight in the first place, they will be tight at all steam temperatures. This overcomes the disadvantage of the double-seated valve mentioned.



Furthermore, the cage and disks can be easily replaced without taking the body from the line. Any practical man knows that it is almost impossible to reseat the conventional double-seated valve without sending it back to the factory, a tedious and expensive performance.

I, therefore, recommend that self-contained, pilot-operated, metal-diaphragm, single-seat regulators be used in most cases, and that in large sizes, where it is necessary to reduce first cost, properly designed double-seated regulators of either the pilot-operated or weight-and-lever type be used.

New York, N. Y. PAULSEN SPENCE

President, Spence Engineering Co.

Cleaning Oil-Soaked Floors

THE method of R. Burns, September *Power,* on cleaning oil-soaked floors, is interesting in that he has called on three sciences, physics, mechanics and chemistry, to assist him.

Gasoline is not satisfactory, as it is lighter than oil, so cannot penetrate it; pyrene should have done better, but is expensive in large quantities, and soda ash and potassium hydroxide have no effect, as mineral oils are not saponifiable.

Lubricating oils seldom have a specific gravity over 0.9 and the 10 per cent sulphuric acid with a specific gravity of 1.07 sinks through the oil and displaces it.

Concrete is a hydrated silicate of lime and alumina. The acids sets free silicic acid and forms calcium sulphate which holds back any oil not displaced and forms an excellent size for subsequent painting.

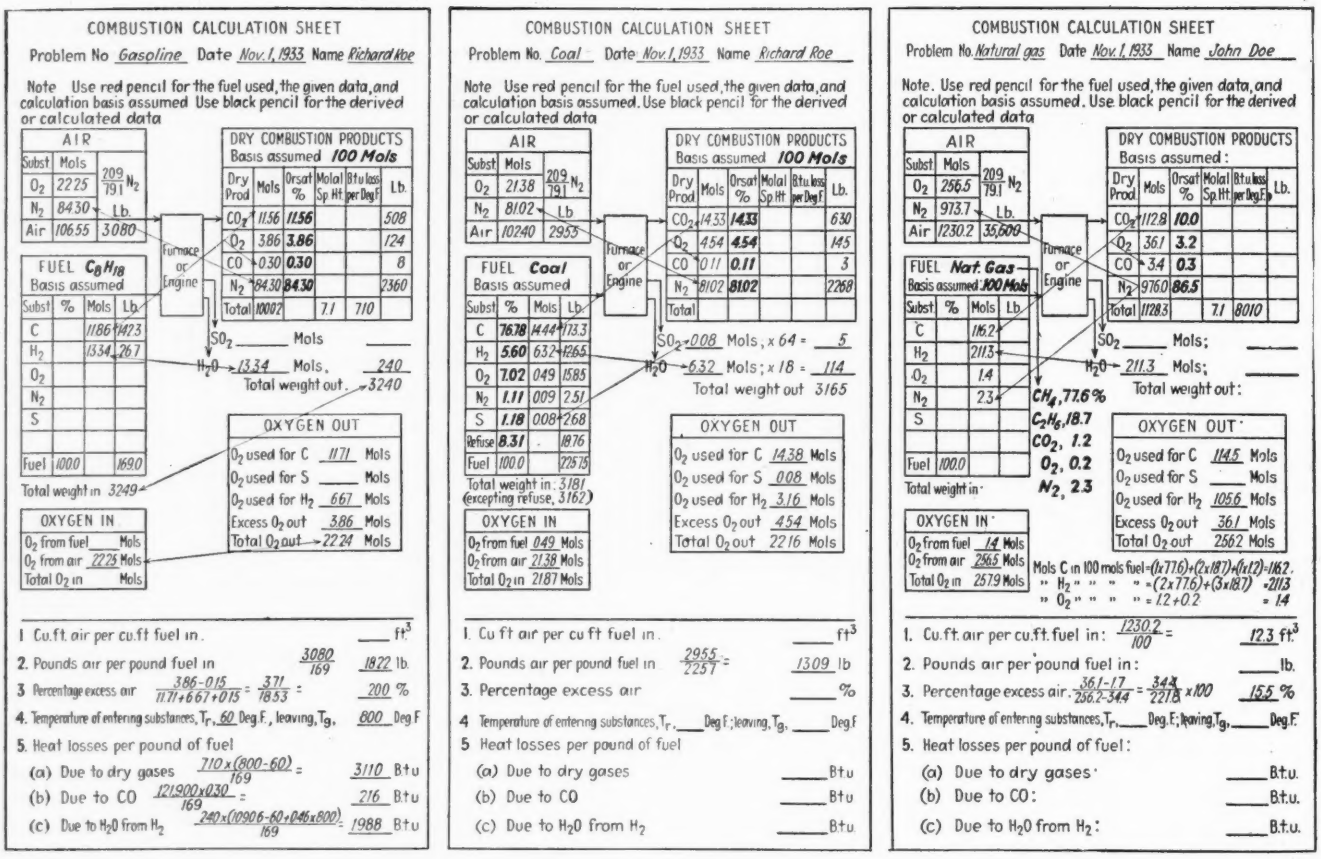
Many concrete paints fail by chipping; the paint holds to the concrete, but litle chips of concrete spall off. Mr. Burns' method should eliminate this. L. R. BAKER

St. Louis, Mo.

PART II

NEW COMBUSTION CHART

SOLVES FUEL PROBLEMS FOR GASOLINE, COAL AND NATURAL GAS


COMBUSTION CALCULATION SHEET
Problem No Gasoline Date Nov. 1, 1933 Name Richard Roe
Note Use red pencil for the fuel used, the given data, and calculation basis assumed Use black pencil for the derived or calculated data
AIR
DRY COMBUSTION PRODUCTS Basis assumed 100 Mols
FUEL C_8H_{18} Basis assumed
Furnace or Engine
OXYGEN OUT
OXYGEN IN
1 Cu.ft. air per cu.ft fuel in.
2. Pounds air per pound fuel in
3 Percentage excess air
4. Temperature of entering substances, T_r, 60 Deg.F., leaving, T_g, 800 Deg.F
5. Heat losses per pound of fuel
(a) Due to dry gases
(b) Due to CO
(c) Due to H_2O from H_2
COMBUSTION CALCULATION SHEET
Problem No. Coal Date Nov. 1, 1933 Name Richard Roe
Note Use red pencil for the fuel used, the given data, and calculation basis assumed. Use black pencil for the derived or calculated data
AIR
DRY COMBUSTION PRODUCTS Basis assumed 100 Mols
FUEL Coal Basis assumed
Furnace or Engine
OXYGEN OUT
OXYGEN IN
1. Cu ft air per cu ft fuel in.
2. Pounds air per pound fuel in
3. Percentage excess air
4 Temperature of entering substances, T_r, Deg F; leaving, T_g, Deg.F
5 Heat losses per pound of fuel
(a) Due to dry gases
(b) Due to CO
(c) Due to H_2O from H_2
COMBUSTION CALCULATION SHEET
Problem No. Natural gas Date Nov. 1, 1933 Name John Doe
Note. Use red pencil for the fuel used, the given data, and calculation basis assumed. Use black pencil for the derived or calculated data
AIR
DRY COMBUSTION PRODUCTS Basis assumed:
FUEL Nat. Gas Basis assumed 100 Mols
Furnace or Engine
CH_4, 77.6%
C_2H_6, 18.7
CO_2, 1.2
O_2, 0.2
N_2, 2.3
OXYGEN OUT
OXYGEN IN
1. Cu.ft. air per cu.ft. fuel in:
2. Pounds air per pound fuel in:
3. Percentage excess air.
4. Temperature of entering substances, T_r, Deg. F; leaving, T_g, Deg. F.
5. Heat losses per pound of fuel:
(a) Due to dry gases:
(b) Due to CO:
(c) Due to H_2O from H_2:

By ERIC THERKELSEN

Professor Mechanical Engineering
Montana State College

THE previous article (Page 600, November *Power*) described and explained a new form for computing combustion problems involving solid, liquid or gaseous fuels. By use of the mimeograph, blue print or zincograph process, any engineer may easily prepare a quantity of these charts for his own use. They are best made on 8½x11-in. letter-size sheets.

As explained in the first article, this form is based on the molal method of computation. While this method, widely used by chemists and petroleum engineers, is still unfamiliar to many power engineers, the latter will find it worth a little study. When one has mastered the molal method, he will find it quicker than other methods. This method will also relieve him of the trouble of carrying or remembering notebook data on the specific weights of various gases.

After explaining the general method of procedure, the November article illustrated the method by working out a problem where methane was burned and flue gas of a given analysis was produced. The present article presents solutions of three additional problems, involving the burning of gasoline (left), coal (center) and natural gas (right).

In these sheets, differing from those last month, the lighter pen lettering is that of the original mimeograph form. Heavy pen lettering represents original data entered in ink. Light pen numbering represents computed figures originally entered in pencil.

Gasoline Burned in Engine

EXAMPLE B.—Gasoline, considered octane (C_8H_{18}), is burned in an automobile engine and the exhaust gases show the following Orsat analysis: CO_2, 11.56 per cent, O_2, 3.86 per cent, CO, 0.3 per cent, 84.3 per cent, N_2. Temperature of the exhaust is 800 deg. F. and atmospheric temperature is 60 deg. F. Calculate (a) weight of air per lb. gasoline, (b) exhaust losses.

Solution: The solution shown in Fig. 1 follows the same procedure as that illustrated for methane in the first article, except that the gasoline is measured by *weight*. The "carbon balance," including the C in the CO_2 and the CO, equals 11.86 mols. The mols of H_2 are $\frac{9}{8} \times 11.86 =$ 13.34 mols. The weight of C is $12 \times 11.86 = 142.3$ lb. and that of $H_2 = 2 \times 13.34 = 26.7$ lb. The weight of gasoline required to produce 100 mols of dry exhaust gases was thus 169.0 lb.

The "nitrogen balance" shows that 3,080 lb. air were used for 169 lb. gasoline, or 18.22 lb. per lb. gasoline.

The 13.34 mols of H_2 produce 13.34 mols H_2O and require 6.67 mols of O_2.

The oxygen accounted for in the "OXYGEN OUT" rectangle includes 0.15 mols O_2 to produce the 0.30 mols of CO.

The heat losses are calculated as shown in lines 5 (a), (b); and (c). The calorific value of CO is 121,900 B.t.u. per mol.

Coal Burned in Furnace

EXAMPLE C.—A coal has the following ultimate analysis in percentage by weight: C, 78.57; H_2, 5.60; O_2, 7.02; N_2, 1.11; S, 1.18; Ash, 6.52. It is burned in a boiler furnace and the flue gases show the following Orsat percentages: CO_2, 14.33; O_2, 4.54; CO, 0.11; N_2, 81.02. Ashpit

refuse is 10 per cent of dry coal fired and was 17.9 per cent combustible (considered C). (a) What is the weight of air used per pound of dry coal fired?

Solution: In this example (Fig. 2) it is necessary to correct the coal analysis by deducting from the carbon the percentage of carbon thrown away with the ashpit refuse. That is $0.100 \times 17.9 = 1.79$ per cent, and must be deducted from the 78.57 and added to the ash as shown in the "FUEL" rectangle.

From the "carbon balance" we know that to form the 14.44 mols of CO_2 and CO in the 100 mols of dry flue gas taken as the basis for calculation, 14.44 mols of C were required. This we write opposite C in the "FUEL" rectangle. Multiplying by 12 we have 173.3 in the "Lb" column.

Now since the coal analysis is on the basis of weight we know we must have had, in the fuel that produced the 100 mols of dry flue gases, $\frac{5.60}{76.78} \times 173.3 = 12.65$ lb. of H_2, $\frac{7.02}{76.78} \times 173.3 = 15.85$ lb. of O_2, $\frac{1.11}{76.78} \times 173.3 = 2.51$ lb. of N_2, $\frac{1.18}{76.78} \times 173.3 = 2.68$ lb. of S, and $\frac{8.31}{76.78} \times 173.3 = 18.76$ lb. of refuse.

These weights are in turn divided by the molecular weights of the substances which gives the figures in mols column, 6.32, 0.49, 0.09, 0.08.

The nitrogen balance indicates that 81.02 mols of N_2 were supplied. Although the coal contained 0.09 mols of N_2 it is customary to ignore this small amount. Then we have 81.02 mols N_2, which is associated with 21.38 mols O_2 in 102.4 mols of air.

The 6.32 mols of H_2 produce 6.32 mols H_2O and require 3.16 mols of O_2. Likewise, the 0.08 mols of S produce 0.08 mols of SO_2 and require 0.08 mols of O_2.

The "OXYGEN IN" rectangle takes account of the fact that 0.49 mols O_2 were supplied by the fuel. The 22.16 mols O_2 going out are thus in reasonable agreement with the 21.87 mols supplied.

The weight of air per pound of fuel is $\frac{2955}{225.7} = 13.09$ lb. (line 2).

The weight of each of the combustion products is obtained by multiplying the mols of each substance by its molecular weight. The weight total of 3,162 lb. on the left side (excepting refuse) is in substantial agreement with the total of 3,165 lb. on the right side, this agreement providing a check on the arithmetic.

Natural Gas Burned in Engine or Furnace

EXAMPLE D—Fig. 3 shows a chart for the calculation of a gaseous fuel[2]. In this example are three new features: (1) the gas fractions in the fuel are first to be reduced to their elementary substances, (2) the fuel percentages are on the basis of volume, and (3) the N_2 content is not neglected.

The fuel gas analysis showed the following percentages: CH_4, 77.6 per cent; C_2H_6, 18.7 per cent; CO, 1.2 per cent; O_2, 0.2 per cent; and N_2 2.3 per cent. The flue gas gave the following Orsat analysis: CO_2, 10 per cent; O_2, 3.2 per cent; CO 0.3 per cent; N_2, 86.5 per cent.

[2]Dec., 1932, Page 293.

A preliminary step in this solution is the reduction of the gas fractions to their elements. The most convenient basis for calculation is 100 mols of the fuel gas. The mols of C, H_2 and O_2 in each fraction of the 100 mols are calculated as shown in Fig. 3.

The carbon balance shows that 116.2 mols C must be divided in the flue gas between CO_2 and CO in the ratio of 10.0 to 0.3, that is, 112.8 mols CO_2 and 3.4 mols CO. The O_2, 36.1 mols, and N_2, 976.0 mols were calculated in a similar manner from the Orsat analysis.

The nitrogen balance makes allowance for 2.3 mols N_2 in the 100 mols of fuel.

The percentage of excess air (or oxygen), line 3, equals the mols of unnecessary oxygen passing out of the furnace divided by the number of mols that must be supplied for perfect combustion, times 100.

There are certain design problems in which it is desirable to calculate the Orsat analysis to be expected when a given fuel is burned with an assumed percentage of excess air. This chart, worked in the reverse direction, is very convenient for such calculations.

RECENT OIL & GAS ENGINE INSTALLATIONS

Gleaned on a 3,000-mile editorial trip

Cooper-Bessemer and McIntosh & Seymour have recently been awarded diesel engine contracts by the Navy Department. McIntosh & Seymour has been awarded four 120-hp. engines; Cooper-Bessemer twelve 8x10½-in., 8-cyl., 300-hp. engines (700 r.p.m., to be delivered to the Coast Guard by Jan. 1); sixteen high-speed (1,200-r.p.m.) units of 120 hp., 6-cyl., 5¾x7¾ in., and eight 1,200-r.p.m. 150-hp., 8-cyl. units of the same bore and stroke.

Recent gas engine installations by Bruce-MacBeth Engine Co., Cleveland, Ohio, include: One 110-hp., 4-cyl. 10x12-in., 327-r.p.m., driving compressor and alternator for Service Ice Co., Paris, Tex. Two 65-hp., 2-cyl., 11x12-in. and a 40-hp., 2-cyl., 8½x9-in., for Independent Ice & Refrigerating Co., Tulsa, Okla. These drive compressors and an alternator. One 110-hp., 4-cyl., 10x12-in., driving compressor and motor for Stephan Ice & Bottling Co., Bryan, Tex., and a 55-hp., 2-cyl., 10x12-in. driving a compressor for the same company. A 165-hp., 4-cyl., 12¼x15-in., running at 277 r.p.m., driving two compressors and an alternator for Heights Ice Co., Houston, Tex., and a 65-hp., 2-cyl., 11x12-in., driving a compressor and an alternator for the same company. An 80-hp., 2-cyl., 12¼x15-in., and a 65-hp., 2-cyl., 11x12-in., each driving a compressor for Conroe (Tex.) Ice Co. Two 65-hp., 2-cyl., 11x12-in., driving compressors and generators for D. M. Jones, Ardmore, Okla. A 130-hp., 4-cyl., 11x12-in., driving generator for the Jaite Co., Jaite, Ohio (previously installed this year are a 165-hp. engine driving a generator and a 250-hp. engine driving a lineshaft in this paper mill). Two 65-hp., 2-cyl., 11x12-in., driving ammonia compressors and generators for Ada (Okla.) Ice Co.

Recent gas engine sales of National Transit Pump & Machine Co., Oil City, Pa., include a 40-hp., 3-cyl., and a 75-hp., 6-cyl., 6x9-in. engines for Pennzoil Co., Rauseville, Pa., both verticals, and a horizontal 90-hp. single-cylinder 17x24-in. to the same company. A 54-hp., 4-cyl., 6x9-in. engine to People's Gas Co., Wilkinsburg, Pa., and a 27-hp., 2-cyl., 6x9-in. engine to Standard Oil Co. of Kansas, for use in the East Texas field. Others include a one-cylinder, 17x24 horizontal for Gulf Refining Co., Neville Island, Pa., a single-cylinder horizontal to Marathon Oil Co., Bristow, Okla., and a twin-cylinder horizontal to National Petroleum Co., Titusville, Pa.

Recent diesel sales of Superior Engine Co., Springfield, Ohio, include three engine-generator sets of 525-kw. capacity for the Goerke & Sons department store, Newark, N. J.; two 245-hp. engines for Sunbury (Pa.) Mill Products Co.; two 215-hp. for United States Navy; a 250-hp. for Hanley Milling Co., Mansfield, Ohio; a 180-hp. for Towsend Petroleum Transportation Co., Baltimore, Md.; a 175-hp. for Hauser Construction Co., Portland, Ore., a 135-hp. for George L. Craig, Long Beach, Calif.; and several smaller engines.

Recent diesel sales of Buckeye Machine Co. include a 150-hp. engine for Siler City (N. C.) Mills, a 112-hp. engine for the cotton gin of J. J. Massey, Manila, Ark., a 150-hp. cotton gin engine for J. H. Hemphill Farms Corp., Kennett, Mo., a 262-hp. diesel for Laurinburg (N. C.) Milling Co., and a similar unit for Ralston Purina Co., St. Louis, Mo., a 187-hp. engine-generator for Independent Life Insurance Bldg., Nashville, Tenn., and a 75-hp. engine-generator set for H. H. Lysinger, Bedford, Pa.

BOILERS PROTECTED BY AMMONIA GAS

● "STEAM boilers, which for one reason or another must remain idle for considerable time, may be protected from rust by being filled with gaseous ammonia, according to experience of the Merseburg ammonia works of the I. G. Farbenindustrie. The boiler is dried as far as possible, filled with ammonia gas from a steel cylinder, and closed hermetically. Ammonia reacts with the remaining moisture, forming hydroxil-ions which act as rust-proofing agents. The dry parts are, of course, sufficiently protected. When it is desired to use the boiler again, it is filled with water entirely, which drives out the gas. Then the excess of water is removed and firing may proceed again."

From a report by W. Lowrie, U. S. Consul General, Frankfort-on-Main, Germany

READERS' PROBLEMS

Motor Speed Increases

WHAT CAUSES MOTOR SPEED TO INCREASE—*We have a 10-hp., 1,150-r.p.m. 220-volt, interpole-type motor, the name plate of which is marked "Shunt wound," but the motor has a series winding on the main poles. This motor operated satisfactorily for several years. Recently it became desirable to increase its speed by a rheostat in series with the shunt field winding. When the field is weakened to give about 25 per cent increase in speed, operation becomes unstable. Motor speed will increase and then decrease, these swings will continue until there is a flash-over on the commutator and the fuses blow. What causes the speed to swing up and down and why a series winding on a machine marked shunt?* —K.B.T.

The series winding consists of a few turns only and is provided to prevent the trouble complained of. In the design of interpole machines, the armature ampere-turns compared to the field ampere-turns are generally made greater than for machines without commutating poles. This is done because there is no necessity to maintain a commutating flux fringing off the main pole tips.

When the motor is loaded, armature cross-magnetization may distort and weaken the main poles and cause an increase in speed. Under such a condition, the motor may fail to reach stable operation and its speed will oscillate up and down. It is to prevent weakening of the main pole under load that the series winding is provided.

A continuous-speed motor is not intended to be operated at increased speed by weakening the shunt field. When the shunt field is weakened, the series winding is not sufficient to compensate for the cross-magnetizing effect of the armature ampere-turns and the motor increases its speed. Adding a turn or two to the series winding might overcome the trouble.

There may be other causes of the trouble. The brushes may have been shifted slightly back of the neutral. It may be that the polarity of the series winding is such as to oppose that of the shunt. It would be advisable to check the polarity of all the field coils to make certain that they are connected properly. The commutating field may be too strong. This can be corrected by increasing the air gap between pole pieces and the armature. If there are shims between the interpoles and the field frame, removing one of these shims may correct the fault. In the absence of shims, machine a small amount off the ends of the poles.

Interesting, but Uneconomical

PLANT AIR CONDITIONING FROM TURBINE—*We have a steam-driven air compressor of 1,000-c.f.m. capacity that is not being used at present, although all of the exhaust steam from it could be used to replace live steam. We can buy, at a low price, a 125-kw. turbine generator, built to operate on 125-lb. steam and exhausting at 8-lb. back pressure and can use the electrical output from this unit. Would it pay or be practicable to operate the steam-driven air compressor during the summer, compressing air to 125 lb., and use the compressed air to operate the turbine generator? In expanding through the turbine, the air will be cooled and can be piped to several departments that are very much in need of air conditioning.*—W. A. H.

Your suggestion is a very interesting one, but from the estimates of power consumed by the compressor, power recovered by the turbine and the refrigeration effect, it would seem that the scheme is not an economical one.

Assuming that very little cooling is done at the air compressor and that the air is received at the turbine at 125 lb. pressure and 200 deg. F., the temperature of the exhaust air would theoretically be about —75 deg. This is too cold for any practical use in air conditioning, and, in addition, under these conditions moisture in the air would condense out and freeze on the blading and nozzles so that in a short time the turbine would be clogged completely with ice. Reheating in the turbine due to its inefficiency would raise this temperature considerably but probably not above freezing.

The theoretical work obtainable from 1,000 cu.ft. per min. of free air expanding from 125-lb. gage and 200-deg. F. to 8-lb. back pressure is about 83.5-hp. This would be the output of the turbine if it could recover all of the energy available in the compressed air.

A turbine generator designed for steam would be wholly unsuited for use with air and its efficiency would be very poor.

The power required to compress 1,000 cu.ft. of air per minute to 125-lb. gage would probably be in the neighborhood of 120 hp. An efficient air turbine might be able to produce 50 hp. of useful energy from this amount of compressed air. This leaves a net cost for the operation of 70 hp.

The refrigeration effect from the exhaust air, even assuming it is possible and practical to get the low temperatures of —75 deg., is—for air conditioning purposes —11 tons. This refrigeration effect for air conditioning purposes could be produced for about 22 hp. in a mechanical refrigeration system. For 22 hp. you could get the same refrigerating effect that you would obtain for 70 hp. with a turbine designed for using air. Thus it appears your suggestion would not work out economically.

QUESTIONS for Our Readers

What Price Exhaust Steam?

Question 1

I SUPPOSE *all* Power *readers will agree that the cost of electricity generated by a steam engine or turbine is the total cost of operating the unit (including steam) less a credit for exhaust steam supplied to heating system and process. Many plants credit the exhaust steam at slightly less than the unit cost of live steam, knocking off 5 to 10%, say, to allow for heat removed by the engine. I question the correctness of this practice, but not on the basis of any quibble about the exact percentage of this small correction. My difficulty is, rather, that during part of the year some exhaust steam is wasted in most plants. Why charge a factory department practically full live-steam rate for soaking up part of this waste by more liberal use of exhaust steam at such times?*

Is there any system of exhaust steam accounting that will get around this difficulty?—H.O.H.

Smoke Indicator

Question 2

I OPERATE *a heating plant in a store building in a large city. Smoke regulations are strict and neighbors watchful, so it is desirable that we avoid visible smoke. What cheap system can we use to discover smoke emission and signal me when it occurs, its duration and its density? Wouldn't a breeching indicator be preferable to a stack unit?*—W.J.T.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

2 Nays; 7 Yeas on Boiler Fuel for Diesel

ANSWER to October Question 1

THE QUESTION

We require a 250-kw. increase in generating facilities. Our present plant uses oil-burning boilers, burning fuel running 18 to 22 deg. Bé. A friend tells me that we can add a diesel engine that will burn this fuel. This would prove attractive for handling our summer load but will a diesel burn this fuel satisfactorily in comparison with regular diesel fuel costing more? Are there any particular precautions required in the use of this fuel in a diesel? We prefer not to complicate our fuel situation if it can be helped. Which type of engine, air or mechanical injection, would prove better?—J.J.P.

New Jersey Says Diesels

FOR an oil to be suitable for diesel use it should have certain qualities which can be

determined by analysis and not by deg. Bé alone. Of course, the latter gives some indication as to whether the oil is a crude, a distillate or a residuum and may even tell the region from which it comes, but before a boiler fuel is used in a diesel, an analysis as to water content, carbon residue, acid, ash and sulphur should be made. To be satisfactory, water should be less than 0.1 per cent and carbon residue 0.5 per cent, sulphur should be under 2 per cent and the oil should be free from acid and ash. An oil of 18-22 deg. Bé should be heated to at least 140 deg. F. to insure proper flow and atomization.

Both mechanical and air-injection diesels operate very economically, but the trend is toward the latter. Whether the oil J.J.P. uses at present is satsifactory or not, I think the heat balance of his plant will be sufficiently improved to warrant installation of a diesel engine even though it is necessary to use a better grade of fuel oil.

Westfield, N. J. GORDON HAHN.

Penna. Sees No Difficulty

THE en bloc Sharples fuel oil clarifier will put 18 to 22 deg. Bé fuel in excellent condition for burning in a diesel. The only precautions required are that if this fuel contains a considerable amount of sulphur, the clarified fuel will still be somewhat dangerous to his engine unless he takes the precaution of starting the engine up on distillate, running during its running time on the clarified heavy boiler fuel and then switching back to distillate for a few minutes before the engine is shut down. In this way the engine will be thoroughly purged of all sulphuric acid vapors and will not deteriorate when idle between runs.

With this precaution, your reader should have no difficulty whatsoever in burning a fuel oil even heavier than 18 deg. Bé.

Philadelphia, Pa. HOMER CLOUKEY,
Sharples Specialty Co.

Ohio Advises Solid Injection

FROM my experience with some of the recent marine engines burning oil of 22 to 26 deg. Bé, I would say it is quite possible to use diesel power here, unless the present oil is of too high ash content. As long as the ash is within A.S.M.E. rating of Bunker C, it should give satisfactory operation.

As to mechanical or air injection—page 215a, April, 1933, *Power*, there was an illustrated diagram of a newly developed injection system for vertical engines giving solid injection with an open-nozzle fuel valve. This engine is built by Cooper-Bessemer Corp.

Springfield, Ohio. HUGH P. JOYCE.

Okla. Says, "Preheat!"

WITH proper fuel system design and attention to operating details, J.J.P. can use 18-22 deg. Bé fuel. 18-22 deg. fuel will ordinarily require heating to be fluid enough to handle through fuel pumps, piping and injection system. Waste heat from the engine exhaust can be conveniently utilized for this purpose, with either an auxiliary heating arrangement for starting or provision for starting on a lighter fuel. Dirt, water or any foreign matter usually encountered in this grade of fuel should be removed by centrifuge or other suitable method.

Many large diesels built in recent years use mechanical injection with very satisfactory results. My preference in a diesel as small as 400 hp. to burn 18-22 deg. fuel would be for the air-injection system.

Oklahoma City, Okla. J. H. BENDER.

Florida Says, "Filter!"

ADDITION of a diesel to your steam plant should in no wise complicate the fuel situation. 18-22 deg. Bé fuel oil is now standardized as a diesel fuel, and we have been using it quite successfully for a number of years in our own plant. I recommend preheating your fuel oil to about 175 deg. F. and the use of edge-type filters with which to clean it.

Two filters should be used, a coarse on the cold side of the heater and a fine filter on the hot side, between the heater and fuel pump. A "backwashing" connection should be provided to each filter so that accumulated "mud" may be washed out the drain. We use exhaust heat from the engine to preheat the fuel; in your plant steam could be used as well, and more conveniently.

A small supply of a light grade of oil, such as distillate, should be used before shutting down; especially so in cold weather. The backwashing connection should be made to this supply.

Vero Beach, Fla. HOMER D. WHITE.

N. Y. Says, "Use Diesel Oil"

I WOULD suggest that since the diesel proposed will have only about 250-kw. capacity, J.J.P. use a regular diesel fuel instead of the 18-22 Bé fuel. Of course, the boiler fuel could be used, but the small saving effected by the difference in price would be more than offset by the trouble or inconvenience given to the operating personnel. If it is decided to use the heavier fuel, I recommend air injection. With regular diesel fuel, I recommend solid injection.

The heavier fuel would have a greater water and sediment content than the regular diesel fuel. This is liable to cause burned-out exhaust valves, cracked pistons and cylinder heads, excessive wear on piston and rings and cylinder walls, which in turn will cause poor compression and unsatisfactory operation in general. The sulphur in the heavier fuel burns to sulphur dioxide or trioxide and if brought into contact with water it forms sulphuric acid. Usually it is necessary to fit special alloy steel valves containing a large per cent of nickel, if a heavy fuel is used.

There are many other reasons why one should use the regular diesel fuel on such a small plant, but those given above are enough to deter one from using the heavy boiler fuel. There is also another important reason. One can be assured of a supply of regular diesel fuel of a high quality, but with improved refining processes being worked out it is probable that the heavier boiler fuels will soon be unsuited under almost any condition for diesel fuel. They will still be ideal, however, for steaming purposes.

New York, N. Y. W. P. LONG.

Mexico Has Been Doing It

WE HAVE operated a 200-hp., 2-cyl., 4-cycle diesel engine of the solid-injection type for more than four years now, on a fuel purchased under a contract calling for 14 plus deg. Bé. The fuel received, however, averages around 22 deg. Bé which our diesel burns without the slightest difficulty. In cold weather, though, the oil is slightly preheated by passing through a hot water-jacketed fuel pot to facilitate its handling. Although this is not strictly necessary in this climate, with only occasional freezing weather during the winter, we found it advisable to do so to ease the work. We also start the engine on a lighter fuel during the coldest weather. A majority of today's diesels are optionally equipped with arrangement for preheating fuel as well as for starting them on lighter grades of fuel, so this can hardly be considered objectionable.

It might be well to mention here, however, that in considering fuel oils for boiler or diesel use, there are several important points to bear in mind, as for instance, the cleanliness as well as the sulphur content of the oil. In connection with the gravity, the viscosity is of major importance, a fact which we only learned after having bought 12,000 gal. of a 26 deg. Bé fuel oil, which had a viscosity so high that it was necessary to admit compressed air into the tank-car in order to force the oil out through the pipes and into our underground storage tank.

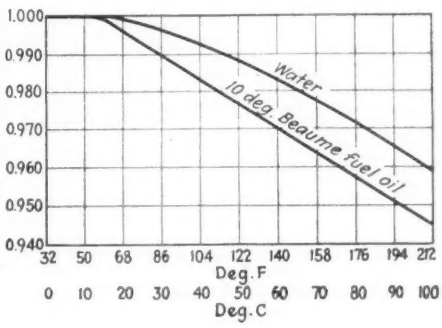
I would recommend the 4-stroke cycle engine of the mechanical-injection type as being best suited, 4 cycle because better combustion is obtained as a rule, and mechanical injection for its simplicity and reliability.

C. Juarez, Chih., Mex. H. MILLER.

Missouri Gives Tests

LOW-GRAVITY fuels may contain water, sand and lime, the first from the use of steam in stilling, the sand as a natural impurity in the crude, and the lime from the calcium hydrate used to bring down the sulphur. Now if these percentages are high (and I have known them to run 50 per cent of the total) any use of such oils is financial suicide. On the other hand, if the impurities are very low, or have been removed by preliminary treatment, there is no reason why the oil should not be satisfactory.

The writer is preparing to continue some tests on a commercial scale, in purifying dirty fuel oils for diesel oil, starting with 24-26 and progressing downward to 10-12 Bé, which is as heavy as water, also some heavier oils if we can get them in commercial quantities. No particular trouble is experienced with oils down to 15 Bé.



(0.966 sp.g.) but in heavier oils, tar oil (1,008) occurs in increasing proportions.

The chart shows the effect of heat on oil and water, the straight line being the expansion of 10 Bé. fuel oil under heat, the curved line that of water. It will be noted that oil expands much faster than water until it reaches a temperature of 185 deg. F., from which point, they expand at the same rate. At this point, the oil has a gravity of 0.9531 while water has only fallen to 0.9687.

J.J.P. can ascertain the probable fitness of his oil, by a few simple tests. Water can be estimated by weighing or measuring half on ounce of oil into a test tube and heating it to boiling point for an hour. The loss or difference is water; solids can be estimated closely by taking a definite sample and diluting with twice as much chloroform or benzol. The solid portion will settle to the bottom, and can be caught on a small filter and weighed. An apothecary's scale is usually available, and one drachm is equivalent to four metric grams.

St. Louis, Mo. L. R. BAKER.

Mass. Summarizes

THE suitability of 18 to 22 deg. Bé. fuel oil depends entirely on its characteristics. Fuel oils varying considerably in character can be successfully burned in a diesel. However, it is extremely important to select a desirable fuel in order to obtain efficient combustion, which, next to effective cooling and good lubrication, is of primary importance. In general, no heavier an oil should be used than can be burned with a clear exhaust.

Low-cost, low-gravity fuel oil is often more expensive to use in the long run than the slightly higher first-cost "diesel" oil because of the impurities and noncombustibles that cause excessive maintenance and wear on engine parts, and because of the necessity of heating heavier fuels to obtain a viscosity that will permit the injection pumps to handle it successfully. In the size mentioned, used only during the summer load, it is doubtful whether it would be feasible and profitable to use the heavy oil unless equipment and facilities are already available for heating and handling it.

The "gravity" of a fuel oil does not indicate whether it is adaptable for diesel use. In fact, many users omit this item from their specifications, for the "gravity" of many oils may be similar but it does not indicate such vital information as viscosity, flash and burning points, heat content, water, acid, sulphur, sediment or ash content.

If the fuel can be heated at all times, 18 to 22 deg. Bé. oil with a Saybolt Furol viscosity of 140 sec. or below at 77 deg. F. may be used providing other characteristics are suitable. In northern climates, if no provision is made for heating or protection from cold, a minimum of 26 deg. Bé. fuel with Saybolt Furol viscosity of 80 sec. or below at 77 deg. F. is recommended. In the south, to avoid special heating and handling, oil of a minimum of 22 deg. Bé. and a Saybolt Furol viscosity at 77 deg. F. of 100 sec. or below could be used.

Fuel with a flash point of not less than 150 deg. F. in a closed tester should be used to avoid fire hazard, and, if a heavy oil requiring heating in order to be successfully handled is to be used, the flash point should be, at least, 20 to 25 deg. higher than the temperature to which it must be heated.

The acid content of the fuel should be as low as possible to avoid pitting of fuel-injection pump, pipe and injection valves. Heat content of the fuel should be 18,500 B.t.u. per lb. or higher. Sulphur content of the oil should not exceed 1 per cent, preferably lower, to avoid formation of sulphuric acid as a product of combustion.

Water absorbs heat in combustion, is corrosive, and incombustible, and often causes cylinders to misfire and water pockets to form in fuel pipes. Fuel should not contain more than 1 per cent of water and sediment combined. Mineral sediment and impurities such as sand, iron oxide, etc., show up as ash on analysis. Ash content should not exceed more than 0.1 per cent. Centrifuging of heavy oils is recommended to remove impurities of this character.

Insoluble carbon and asphaltic substances are, also, detrimental, as they cause a gummy deposit on valves and rings.

Modern mechanical-injection systems are suitable for handling any fuel and will give lower fuel consumptions than the air injection system. In addition, mechanical injection eliminates the always troublesome high-pressure air compressor, which usually gives more trouble and requires more maintenance than the rest of the engine combined.

Boston, Mass. JOEL W. REYNOLDS.

Keeping Grease and Oil Apart

ANSWER to October Question

THE QUESTION

On our heavy-duty traction motors, the load is driven by a gear on which we use a heavy gear compound for lubrication. The end of the motor bearing is ½ in. from the gear and one end is open to the gear case. No oil slingers or baffles of any kind are on the driving shaft. Consequently when bearing clearance increases, oil flows out the bearing end into the gear case and softens the grease. The grease then in turn enters the bearing and causes overheating. I will appreciate suggestions from Power *readers.* W.A.P.

Traction-Motor Experience Adapted

I HAVE had experience with thousands of traction motors and have had the same trouble, but have never had the grease work back from the gear case to the bearing. I don't see how it can if the oil is flowing out to the gear case, since the oil tends to keep the grease washed away from the bearing.

Considerable difficulty has been experienced on New York subway systems with oil working out into gear grease, and breaking down the consistency.

If motors are ring or chain oiled, I would suggest that the capacity of the ring or chain be reduced by substituting one narrower so that the bearing will not be flooded to such an extent. If the bearing has a wick or wool-waste oil feed, as most of them have, it is rather difficult to regulate the feed, since temperatures of bearing and atmosphere both affect oil feed. The warmer the bearing or housing the greater the oil feed, because of the reduced viscosity of the oil. It is principally for this reason that a heavy-bodied oil is recommended for traction-motor armature bearings.

It has been the thought of some that it would be possible to operate traction motor armature bearings all year 'round with what is generally known as a winter oil—one with a lower viscosity than that generally used for the summer months. I have found that it is best to use the seasonal oils, winter and summer grades. If the winter or lighter viscosity oil is used in the summer, the lighter viscosity causes it to feed too fast and it flows over into the gear case and on the other side onto the motor windings. In the first case it thins out the gear grease and in the second case shorts the windings and cables. I have seen motors with burned depressions in the frames almost large enough to set a half walnut shell in them caused by oil-soaked cables.

It is suggested that an oil having about 85 to 90 sec. S.U. at 210 deg. F. and 05F pour be used for summer, and one with 60 to 65 sec. S.U. at 210 deg. F. and 0F max. pour, be used for winter in the middle Atlantic states. The viscosity at 100 deg. F. will vary, depending on the nature of the crude, whether napthenic or paraffine base. Usually oils for this service are made from napthenic base crudes.

It is appreciated that oils of such viscosities are far heavier than ordinarily used for motor bearings, but actual service with thousands of traction motors over about twenty million car miles a month has upset whatever theory might exist regarding the proper type of oil for armature bearings.

With reference to the gear grease: It is necessary to get exactly the right type of grease. All refiners produce gear greases, and probably all appear to be the same, but in actual practice there is a vast difference. Some greases will thin out just by the action of the gears. All do to some extent, but there are superior gear greases. Oil from the armature bearings will thin out the grease too, but the superior greases will stand up far longer than the ordinary kind which are made as a byproduct and not run especially for gear lubricants.

It is suggested that a gear grease with a viscosity of 480 to 520 sec. Furol at 210 deg. F. be used for summer lubrication of traction gears, and one having a viscosity of about 200 sec. Furol at 210 deg. F. be used for winter lubrication. One of the large systems uses the heavier grade all the year round. If the equipment is in a temperate climate, such as exists say in the Carolinas, I would suggest the heavier grease for year 'round service. If the equipment is indoors the heavier grease should be used. Some years ago it was customary to use much lighter greases than these, but severe service has demonstrated the superiority of heavier greases.

New York City. W. P. LONG.

THE ENGINEER'S BOOKSHELF

Heat Transfer

INDUSTRIAL HEAT TRANSFER (1933)—*By Alfred Schack, Dr.-Ing., translated from the German by Hans Goldschmidt, Dr.-Ing. and Everett P. Partridge, Ph.D. Published by John Wiley & Sons, Inc., New York City. 371 pages. Price $5.*

This is the sort of book that compels admiration, for the quantity of information it contains and for the thoroughness with which the subject is treated. Both author and translators stress the point that the book is designed to serve the interests of the practical engineer in the field. This statement is undoubtedly correct, if the word practical is properly interpreted. Clearly the book is not designed for the average operating engineer or even the average consulting engineer, but for the man who must work out mathematically the detailed design of heat-transfer equipment.

Special emphasis has been placed on the development of equations that would be simple in form without sacrificing exactness.

In the translation the equations and tables have been refigured into English units throughout and an elaborate system of cross-reference developed for the convenience of the reader.

The main divisions of the book are: The Three Ways in Which Heat is Transferred and the Surface Conductance, Analysis of the Three Mechanisms for Heat Transfer, Calculations for Heat Exchangers, Heat Transfer in Industrial Furnaces, Heat Transmission and Pressure Drop, Numerical Examples in Heat Transfer, Compilation of the Most Important Equations for Heat Transfer, Important Physical Constants for Heat Transfer, Literature Cited.

Thermodynamics

STEAM AND GAS ENGINEERING—(2nd Edition)—*By Thomas E. Butterfield, Burgess M. Jennings and Alexander W. Luce, professors at Lehigh University. Published by D. Van Nostrand Company, Inc., 250 Fourth Ave., New York City. 488 pages, 6x9 in. Cloth. Indexed and 332 illustrations. Price $4.50.*

Simplification of thermodynamic calculations has been the aim of this complete rewriting of the 4-year-old first edition. Increasing use of high-pressure steam has led the authors to include precise methods of making calculations involving steam quantities in addition to the usual methods suitable for low pressures. The symbol h has replaced the terms "total heat," enthalpy or "heat content." The binary-vapor cycle, the regenerative feed-water heating cycle and the reheating cycle are described. Increased attention has been given to efficiency, heat balance and thermal calculations. Performance data for stokers, boilers, turbines, steam engines and internal-combustion engines are included. The chapter on combustion is simplified, and information on pulverized-coal apparatus, for gas and liquid fuel burning, has been increased. Chapters on pumps and refrigeration are included. Examples and problems are given throughout.

Small Water-Power Plants

POWER DEVELOPMENT OF SMALL STREAMS. (2ND EDITION)—*By Carl C. Harris and Samuel O. Rice. Published by Rodney Hunt Machine Co., Orange, Mass. Cloth; 177 pages, 6x9 in. Illustrated.*

Most of the books on water-power developments deal with the larger projects. This book as the title indicates is devoted to development of water powers for small streams. Its purpose is to furnish the layman in an accurate and simple way a practical and working knowledge of installing and operating small water-power plants for supplying country homes, towns and villages with electric light, power, water supply and fire protection. The work is divided into 14 chapters and includes such subjects as gaging of streams, weir measurements, types of water wheels, dams, conduits, concrete, installing a water-power plant and an appendix of tables giving water-wheel size and rating and other useful data.

Diesel Instruction

DIESEL CORRESPONDENCE COURSE. *Books I, II and III, Fundamentals and Principles, Treatise on Fuel and Lubricating Oils, and Operation and Maintenance of Engine. Paper-backed booklets, 5x7½ in., forming first three texts of the course sponsored by Industrial Institute, Inc., 897-901 Bergen Ave., Jersey City, N. J.*

Diesel correspondence courses must needs have their texts. These are handy, foldable booklets of 16 to 32 pages, giving in concise, plain language the elements of diesel engineering. Subjects are handled logically, and questions are provided at the end of each booklet for the student to answer in writing. If this reviewer were to criticise, the criticism would be on the illustrations used, which are often so small as to preclude the possibility of the careful study necessary for comprehensive understanding of the engine discussed. In some places, copy editing would have clarified the writing and made it much more readily understandable.

Electric Circuits

DIRECT- AND ALTERNATING - CURRENTS, THEORY AND MACHINERY (1933) — *By E. A. Loew, professor of Electrical Machinery, University of Washington. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York City and London, England. Cloth; 656 pages, 6x9 in.; illustrated. Price $4.50.*

Intended primarily for students wishing a short survey course in the theory of electric circuits and operating principles of electric machines, this book combines a mathematical treatment with a goodly amount of explanation on how the equipment functions. Side by side are found treatments that are usually found in practical electrical books with those generally associated with college text-books. This is probably a happy combination as it meets the needs of both qualitative as well as quantitative thinking.

Practically all commercial types of direct-current and alternating-current machinery have been given attention, including electron tubes and rectifiers. The book is intended as a text, but practicing engineers will also find it a handy reference.

Electron Tubes

ELECTRONS AT WORK (1933)—*By C. R. Underhill, consulting engineer. Published by McGraw-Hill Book Co., Inc., 330 W. 42d St., New York City and London. 354 pages, 6x9 in. Cloth. 220 illustrations. Price $3.*

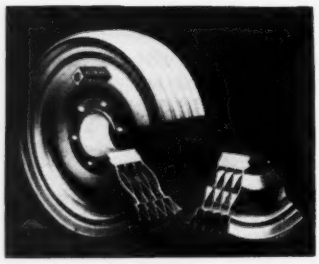
Within a few years engineers have been presented with a new and almost magic tool, the electronic tube, about which many would like to have a better understanding. This book has been written to meet that desire. It presents for the engineer, student and general reader a clear and simple explanation of how electron tubes work and details many of their practical applications. Among the topics covered are: fundamental quantities; oscillations; vacuum tubes; gaseous-discharge lamps and tubes; photoelectric cells, their circuits and use; cathode ray tubes; invisible light; alpha, gamma, beta, cosmic and X-rays; neutrons, positrons; ductrons and the artificial disintegration of matter. The treatment is in semi-popular style and has been made so readable that the book is worthy of a place with those popular scientific works that within recent years have attained the enviable position of best sellers.

Arc-Welding Encyclopedia

PROCEDURE HANDBOOK OF ARC-WELDING DESIGN AND PRACTICE (1933)—*Prepared and published by Lincoln Electric Co., Cleveland, Ohio. 434 pages, 5¾x9 in. Flexible simulated leather covers. Indexed 500 illustrations. Price $1.50.*

Compiling in one volume complete and up-to-the-minute information on arc-welding design and procedure, this book is practically an arc-welding encyclopedia. It is divided into eight principal sections, covering: Welding Methods and Equipment, Technique of Welding, Welding Procedure Speeds and Costs, Structures and Properties of Weld Metal, Weldability of Metals, Designing for Arc-Welded, Steel Construction of Machinery, Design for Arc-Welded Fabrication of Steel Structures, Typical Applications of Arc Welding in Manufacturing Construction and Maintenance. Each description is clear and concise and well illustrated.

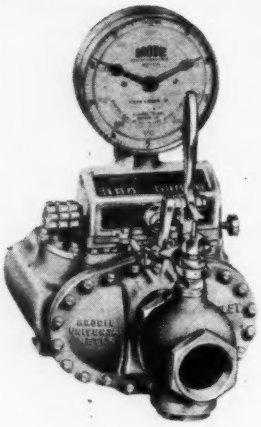
WHAT'S NEW IN PLANT EQUIPMENT



Steel V-belt Sheaves

Texrope V-belt drive with one or both sheaves "Texsteel" are now available from ¼ to 15 hp. Grid-type construction as shown with accurately formed heavy-gage steel sections electrically welded at web and rim. Outer rims rolled for protection, appearance, strength. Integral bushings or solid-bored hubs standard. Finished in aluminum.

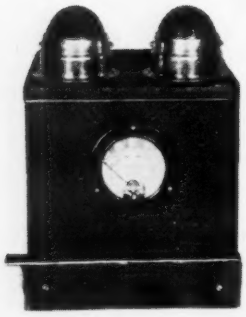
Allis-Chalmers Mfg. Co., Milwaukee, Wis.



Quantrol-Equipped Meter

Brodie Quantrol - equipped meter automatically measures given quantities of fuel oil or gasoline. Vertical type, illustrated, has extra large dial. Quantrol is set to quantity desired and outlet valve opened; shut-off is automatic when metered quantity is dumped.

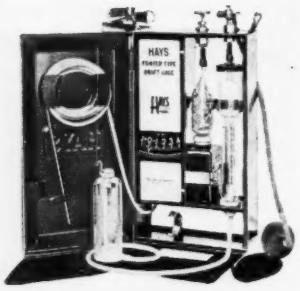
R. N. Brodie Co., Inc., 967 61st St., Oakland, Cal.



Combustion Indicator

Most firemen know they get greatest economy when stack gases are near haze point. Ess Combustion Indicator uses photoelectric cell to keep constant supervision over stack gases. Electric eye, many times as sensitive as human eye, will record very small changes in gas density. Meter provided gives continuous indication of haze. Visible or audible signals can be provided to give warning when haze varies. In instrument shown, a red light indicates lack of air, or smoke, and a green light indicates excess air. As long as neither light shows, operator knows he is operating in desired zone.

Ess Instrument Co., 30 Church St., New York City.



Combustion Test Set

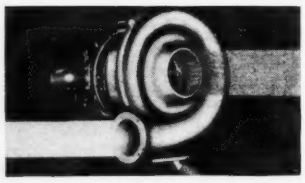
Series 3,000 Hays combustion test set combines fast Orsat gas analyzer with pointer-type draft gage in spot-welded steel case, 7¾x5x15 in. Wt. 9 lb. Gas analyzer range 0-21 per cent. Highly sensitive draft gage has no liquids and requires no leveling in two ranges, +.1 to 0 to —.4 in. and 0 to — 1 in. Flue-gas thermometer with range 200-800 deg. F. supplied if desired. Is fountainpen type 5 in. long. with 10-deg. graduations. Bulletin 2,009.

The Hays Corp., Michigan City, Ind.

Mechanical Tube Cleaner

"Drill-Drive" is straight-line, tubular, telescoping driving device with automatic clutch using latest type Tubrush and ½-in. or larger electric drill. Requires no lubrication. Adaptable for tubes 2 in. or larger in lengths up to 20 ft.

Tube Cleaning & Equipment Co., 90 Ames Bldg., 1 Court St., Boston, Mass.



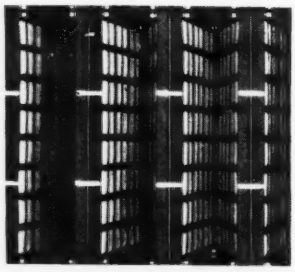
Combined Blower and Dust Collector

"Roto-Clone" dynamic precipitator is exhauster and dust separator combined, for conveying and collecting process dust. Entire unit no larger than usual exhauster and efficiency as great or greater than two units formerly used. Available belt-driven, direct-driven and self-contained with hopper and stand. Complete data in Bulletin 270-F.

American Air Filter Co., Inc., 1st and Central Aves., Louisville, Ky.

Air Filter

"Multi-V-type" filter units are a series of small filters in multiple V shape, so that active filtering surface is equal to 27 times face area. Velocities through filter medium are maintained at low figure. Positive, dry-type filter medium used as in previous "Protectomotor." Cells can be in accordion arrangement for positioning in long ducts. Light-weight fiberboard cell frame. Several different sizes and arrangements: Standard 20x20-in. size, 4¼ in. deep and accommodating up to 800 c.f.m. Other sizes handle up to 3,000 c.f.m. at velocity of 28 f.p.m. Panel cells available with capacities 90 to 900 c.f.m.



Staynew Filter Corp., Rochester, N. Y.

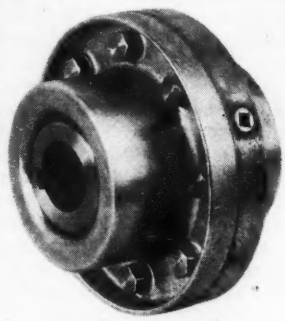
Underground Conduit

Goodyear-Graybar electrical conduit has high resistance to water absorption and fire. High impact and crushing strength even at high and low temperatures. Inside surface smooth and does not exude impregnating compound. Sizes from 5 to 8 ft. long and 1- to 6-in. inside diameter.

Graybar Electric Co., Graybar Bldg., New York City.

Light-Duty Coupling

This light-duty Fast's coupling has usual internal and external gears constantly in mesh in oil-filled casing. Die-cast zinc-base casing permits low-cost unit for light duty, hubs forged steel. Sizes 1 to 2⅛ in., 2-15 hp. per 100 r.p.m. and maximum speed of 3,600 r.p.m.



Bartlett Hayward Co., Baltimore, Md.

Motor-Compressor

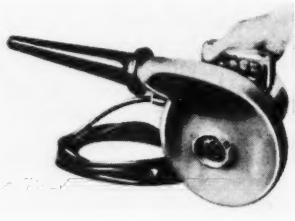
"Motorcompressor" unit a new air compressor requiring no cooling water. Has built-in motor, with rotor on compressor shaft and frame bolted to compressor crankcase, thus avoiding couplings and motor bearings. 2-cyl., 2-stage, with cylinders and intercooler air cooled. Sizes 20 to 50-hp., 113 to 310 c.f.m. and discharge pressures up to 125 lb. gage. 16-page catalog

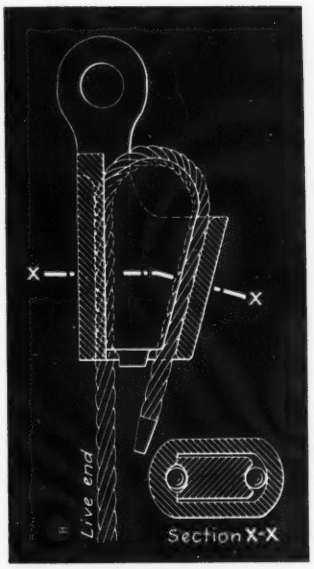
Ingersoll-Rand Co., 11 Broadway, New York City.

Portable Electric Blower

Tornado Model 10 blows dust out of motors and machines, etc. Light weight and large power in small space. Uses 1-hp. ball bearing motor, which, with special fan, gives 46½-in. water lift.

Breuer Electric Mfg. Co., 852 Blackhawk St., Chicago, Ill.





Wedge Socket for Wire Rope

In usual wedge sockets, excessive pressures are frequently concentrated on live side of rope at upper end of socket basket. To overcome this difficulty, this new type wedge socket will develop more than 90 per cent of ultimate rope strength. Known as "No-pinch" type. As indicated in figure, only a predetermined amount of pressure can be applied to pull end of rope. If rope tension increases sufficiently to pull wedge further into socket, machined bearing surfaces in contact transfer additional pressure to dead side of rope, which carries smaller part of load. Therefore, this additional load being confined to dead side will not affect strength of rope at attachment. New sockets are available for ropes ranging in size from $\frac{3}{8}$- to $2\frac{3}{8}$-in. in diameter.

John A. Roebling's Sons Co., Trenton, N. J.

Duplex Hydraulic Valve

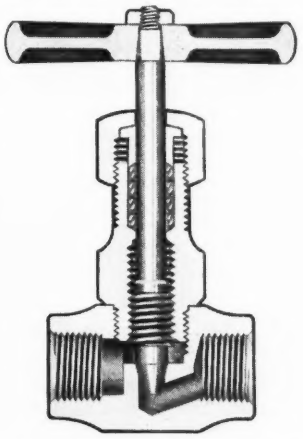
This valve is entirely separate from main piston and will operate cylinders in any location without valve gear. Only two pipe lines connect valve with operating cylinder. While unit can be applied to hydraulic drive, it was designed for stoker drive.

Should stoker plunger encounter obstruction sufficient to stop it, motion of plunger is immediately reversed. Stoker will continue to make short strokes until obstruction is crushed or removed. In general, valve operates similarly to Worthington plunger-type meter, except that valve plunger cannot pass center until hydraulic pressure builds up sufficiently to force plunger past vertical spring-loaded wedge *A*. This occurs each time operating piston comes to end of stroke or strikes obstruction. Only the plunger chamber shown connects to operating cylinder. There are no centers, because one valve plunger operates slide valve controlling inlet and exhaust ports of opposite plunger.

W. J. Woodcock, 102 Gates Ave., Brooklyn, N. Y.

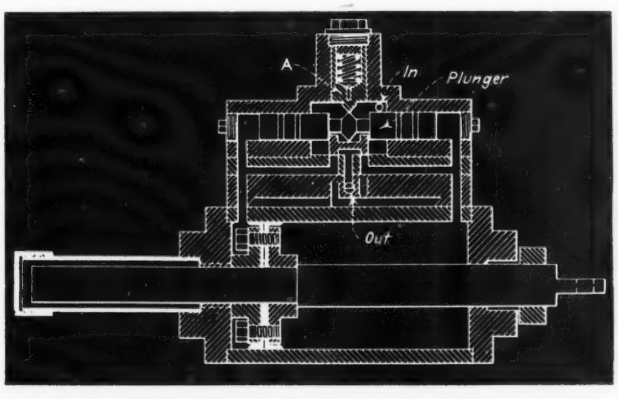
High-Pressure Needle Valve

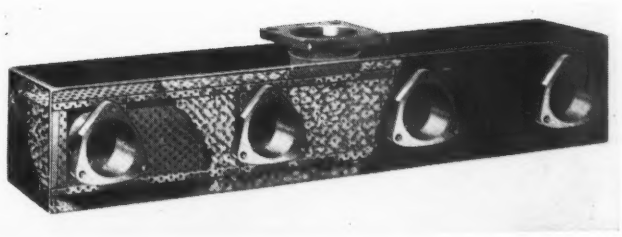
Made from carbon steel or high-chrome stainless iron, these small, compact valves are suitable in measuring pressures or volume of flow of fluids or



gases where gradual release of pressure is essential to prevent damage to gages or meters. Long pipe threads, long stem threads, deep stuffing box with gland, metal-to-metal bonnet joint, long tapered plug disk, long bonnet thread.

Crane Co., 836 S. Michigan Ave., Chicago, Ill.





Combination Muffler-Silencer

This manifold, for either exhaust or intake, incorporates silencing effects ordinarily performed by separate muffler. Sound absorption is accomplished by porous material faced with perforated metal lining through which gases pass. Lining is so perforated that sound penetrates absorbent material freely but gas flow is not appreciably impeded. No baffle plates or other deflectors obstruct flow of gases, resulting in minimum back pressure. Initial efficiency maintained because soot or carbon does not accumulate. Unburned gases are not trapped — reducing possibility of muffler explosions.

Burgess Battery Co., Madison, Wis.

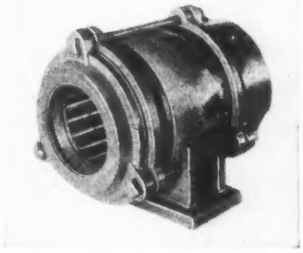
Hydrometer

Supplied in both plain and combined forms, these certified hydrometers have longer and wider metal scales, permitting temperature determinations as close as plus or minus 0.25 deg. F., particularly important because variation of 1 deg. can introduce error of as much as 0.2 deg. A.P.I. in gravity readings. Streamline tip for ease in cleaning, faster sinking in heavy oils and to permit use of sensitive thermometer bulb. Solid metal ballast; scale 25% longer than usual paper scale, yellow with black figures for ease of reading. Double gravity scale can be read from any point. Circular 1070.

C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.

Industrial Roller Bearing

Conventional inner and outer rings and roller cage assembly



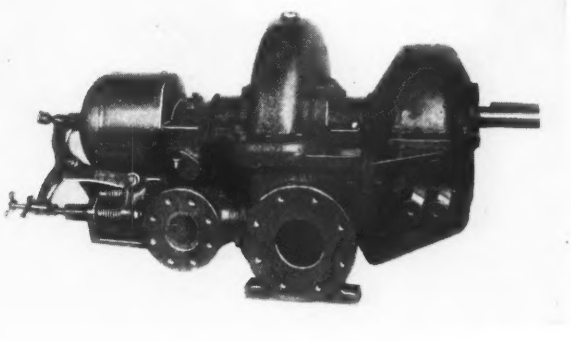
used in this roller bearing for industrial applications. Alloy steel permits heavy-duty service. Increased roll length or two rolls of rollers provide additional capacity where necessary. Rollers held in place by spacer bars rather than by rivets through rollers. Design provides for some heat expansion without affecting bearing. Variety from $3\frac{1}{2}$- to $7\frac{3}{8}$-in. shaft diameter. Pillow block illustrated furnished with bolted-on end covers to permit easy assembly and dis-assembly. Standard single-roll radial ball bearing takes thrust load.

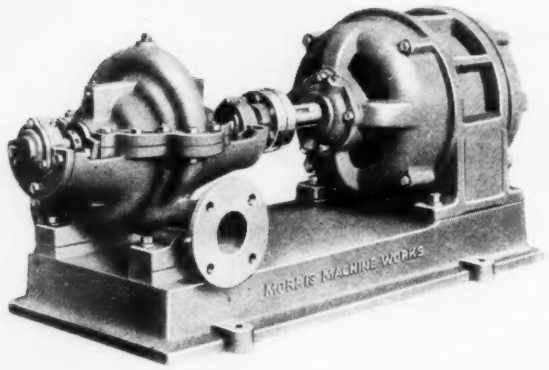
Fafnir Roller Bearing Co., New Britain, Conn.

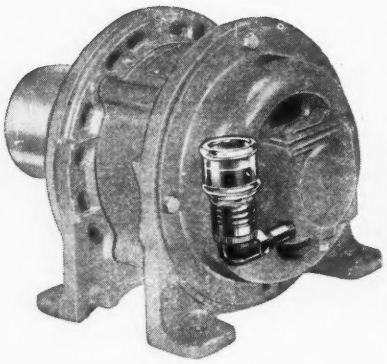
Close-Coupled Turbine-Gear Sets

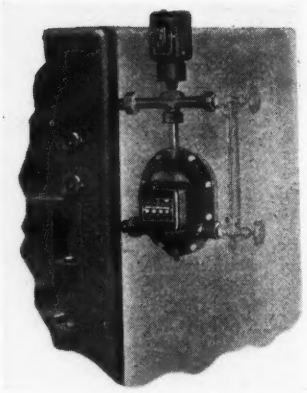
Consisting of steam turbine and reducing gear, these close-coupled sets are designed to drive centrifugal pumps, fans and other relatively low-speed apparatus through gearing. Sets particularly suitable where exhaust steam can be used for heating. Self-lubricated. Housings bolted together to form single structure supported on turbine base. Steam pressures up to 400 lb., temperatures to 750 deg. F. and back pressures to 40 lb. gage. Speed of low-speed shaft 180 to 3,000 r.p.m. Capacity from 10 to 150 hp.

General Electric Co., Schenectady, N. Y.





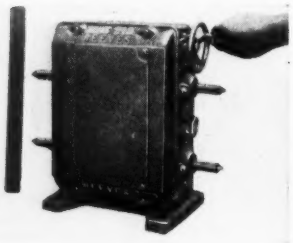




Double-Suction Split-Case Pump

This line of double-suction, split-case pumps is especially designed for high-speed operation. Suitable for direct connection to electric motors or steam turbines running at 3,500 r.p.m. May also be belt driven or operated through gears by low-speed drivers such as gasoline engines. Special care in finishing impeller and careful dynamic balancing of parts avoids high-speed trouble. Deep-groove, heavy-duty precision ball bearings handle all thrust loads. Sizes from ½ to 5 in. for general pumping, factory and process work, municipal water supply and for handling other liquids.

Morris Machine Works, Baldwinsville, N. Y.



Variable-Speed Transmission

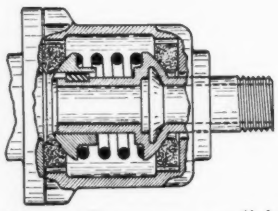
No. 0000 vertical, enclosed, variable-speed transmission is under 14 in. high and particularly recommended for small-space, low-horsepower installations, under severe service. Centralized force-feed lubrication. Cast-iron case protects against water, abrasives and fumes. Width, not including handwheel, 11¼ in., thickness, 7 7/8 in., weight 70 lb. Infinite speed adjustment from 2:1 to 6:1, capacity ¼ to ⅜ hp.

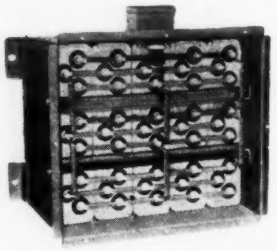
Reeves Pulley Co., Columbus, Ind.

Rotary Pressure Joint

This rotary pressure joint for steam, gases, water, etc., uses special carbon - graphite seal rings that do not require lubrication. Pressure equalizing within joint seals polished concave surfaces of seal rings against chromium cast - iron spherical flanges. Light spring merely holds the parts in place. Pressure seal eliminates external adjusting spring ordinarily used to compensate for pressure changes. Lateral movement possible in addition to angular movement allows flexibility to compensate for piping or bearing irregularities. Steam pressures exceeding 200 lb. and speeds of 200 r.p.m., also on water, refrigerated brine, etc. Sizes ¾ to 3 in.

Johnson Corp., Three Rivers, Mich.





Capacitor for Power-Factor Correction

These capacitors (static condensers) are an assembly of small hermetically sealed can units, each heat-treated and impregnated with oil under vacuum. Fuses sealed in can under oil. Box-type units furnished in welded sheet-steel cases with weatherproof covers. Rack-type units in sizes over 30 kva. with either weatherproof housing or steel screen enclosure for indoor use. All voltages up to 4,600 and any frequency and phase arrangement; any size desired.

Ideal Electric & Mfg., Co., Mansfield, Ohio.

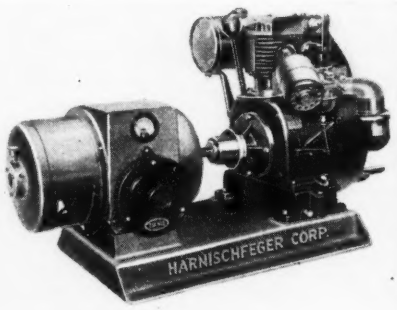
Constant-Level Oiler

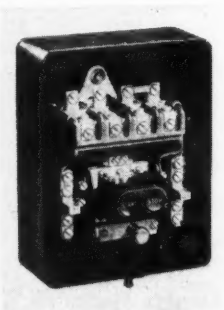
Designed especially for use on electric motor bearings and other bearings with oil-ring, packing, or ball or roller bearings where oil in reservoir should be maintained at predetermined level. Tube permits air to enter and oil to flow when bearing reservoir level drops below fixed point. Automatically stops when proper level is reached. Visible oil supply.

Speedway Mfg. Co., 1834 S. 52nd St., Chicago, Ill.

Portable Lighting Plant

Small, heavy-duty line of lighting plants consists of 1- or 2-cyl. gasoline engine direct coupled to compound - wound continuous generator. Push-button or manual starting. Capacities from 400 watts to 3 kw., generating 35- or 120-volt d.c. Greater capacities by 4- and 6-cyl. gasoline-generator sets with range 1½ to 60 kw. Also diesel sets in 35- and 50-kw. units, using half as much and cheaper fuel. High reserve capacity, simple design.





Electrical Division, Harnischfeger Corp., Milwaukee, Wis.

Low-Water Control

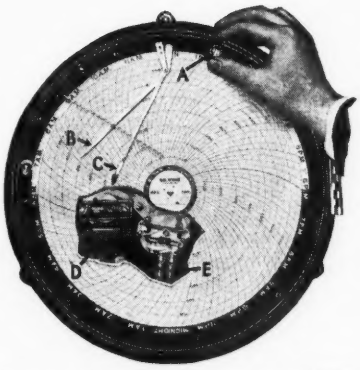
This bellows-sealed, packless, low-water cutoff, duplex switch and water feeder permits low-water protection at small cost. Designed for gage-glass mounting. Offers both types of low-water protection — low-water cutoff operates mercury switch in electrical circuit to cutoff power until boiler is manually refilled, or automatic switch may be added for automatic boiler refilling by means of solenoid-operated valve. If water feeder valve is not used, connections for it may be used to operate an alarm bell. Steam- or vapor-pressure control or vacuum control may be screwed into built-in syphon on top of cutoff to make it a duplex switch, providing high-limit control and automatic shutdown for low water. Water feeder may also be used with duplex switch for use with low-water cutoff. Pressure or vacuum to 25 lb.

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Automatic Across-the-Line Switch

Rated at 5-hp., 220 volts; 7½-hp., 440 and 550 volts for polyphase motors, and up to 1½-hp., 110 volts; 3-hp., 220 volts for single-phase, self-starting motors, this solenoid-operated, across-the-line starting switch is made in three forms: start and stop push-buttons; without pushbuttons for thermostat or remote pilot control; and 2-way hand-automatic switch for "try-out" control installations. Reduction of dimensions of switching mechanism makes unit smaller. Double-break silver alloy contacts. New arc hood. Two Resisto-Therm relays with interchangeable thermal elements provide overload protection. Switching units self insulated for mounting in groups if preferred.

Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis.



Records and Controls Temperatures up to 1200° F.
(a) Knob for changing setting of B. (b) Index showing temperature at which control is set. (c) Temperature pen. (d) Electric motor selects switch position, depending upon relation of C to B. (e) Mercury in glass switches, capacity 15 amperes at 110 volts, positive in action, are mechanically positioned by motor D. No power required from pen. Eliminate relays in most applications.

Mercury-Switch Thermometer Controller

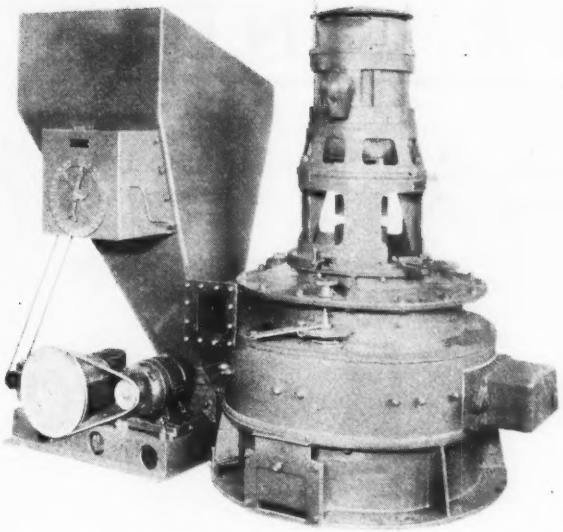
Mercury switches eliminate open make-and-break contacts controlled by pen arm in this automatic-control thermometer. Every 6 sec., motor-driven control table determines location of pen on chart in reference to control setting and tilts mercury switch if temperature has changed. Thus measuring mechanism is free to position itself unhampered by control mechanism, and pressure and contact difficulties are avoided. Switches have capacities up to 15 amp. at 110 volts (10 amp. at 220 volts) thus eliminating external relays in most applications. Control mechanism adaptable to 1-, 2- or 3-contact control systems. In 2-record controller, each control mechanism can handle a separate device, may be used independently and each has its own control index. Unit also supplied as time-temperature cycle controller, with transparent cam shifting control index with relation to time. All models in circular 10-in. or 14-in. dustproof cases and offer advantages of recently announced recording thermometer and pressure gage. For control of pressure, liquid level, and other factors as well as temperature. Catalog No. 6702.

Brown Instrument Co., Philadelphia, Pa.

Air-Separation Pulverizer

Novel principle of air separation, eliminating use of bulky separators or cyclones, employed in these vertical pulverizers. Pulverized material remains in pulverizing chamber until fine enough to be withdrawn by blower built integral with pulverizer and driven from its shaft. Screw feeder through Link-Belt variable-speed transmission (running in oil) may be connected up for automatic-control operation. When hot air is introduced into pulverizing chamber, water-cooled bearings are used. Three sizes, with capacities 50 to 3,500 lb. per hr.

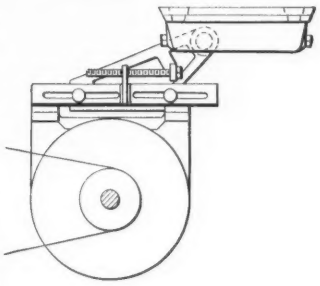
Whiting Corp., Harvey, Ill.



Compensating Belt Drives

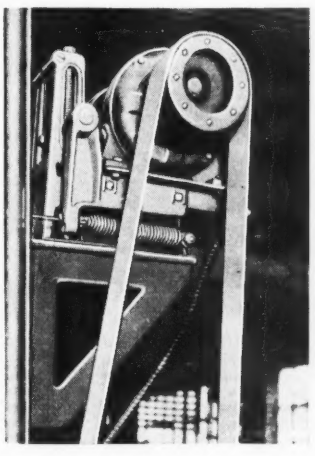
Ceiling-drive bases (diagram) and vertical-drive bases (photo) have been added to the Rockwood type drives. Ceiling unit is similar to standard unit except that special hanger arms suspend motor horizontally and give greater ceiling clearance. Adjustable steel angles supported by ledge cast on bottoms of hanger arms. These ledges take weight of motor from slotted-head screws in arm slot. Thus screws may be loosened and adjusting angles moved by secondary tension - adjusting screws while drive is running. One-man adjustment attained, and without auxiliary support for motor. Safety chain catches motor if belt or fastener fails.

Vertical - drive base differs from standard unit in that force producing tension is derived from coil springs instead of motor weight. When motor is *above* driven pulley, springs are adjusted to support motor



weight *plus* tension; when below, springs carry that portion of motor weight *not* required for belt tension. Adjusted easily while running by turning two nuts on ends of coil-spring rods.

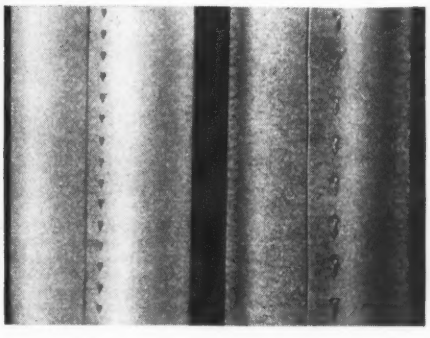
Rockwood Mfg. Co., Indianapolis, Ind.



Metal Stitch for Insulation

Two types, first for applying heavy canvas over heat insulation on pipes, ducts, etc., other for applying jackets of roofing. Essentially a metal strip with arrowhead-shaped prongs bent out at right angles to strip. Occasional short nails through strip secure it to insulation. First edge of canvas is forced over prongs at intervals, then special roller pushes canvas down over all prongs. Other edge of canvas similarly applied, then all prongs bent back flat by running round bar along line of prongs. Roofing covers are similarly applied, except that prongs are longer and spaced at 1-in. intervals. Bulletin 105.

The Philip Carey Co., Lockland, Cincinnati, Ohio.



Constant Level Oil Control

"Alvor" oil controls maintain constant oil level automatically in ring-oiled bearings or anti-friction bearings suitable for oil-bath lubrication. Waste is avoided and glass bottle shows oil supply. Operates on liquid-seal principle. Feeds only when bearing oil level drops below shank end, breaking seal and permitting air to enter bottle. Adjusting collar allows ½-in. vertical adjustment to alter oil level in bearing. Refilled by lifting bottle and base from T connection. Folder F-595.

The Lunkenheimer Co., Cincinnati, Ohio.

Improved Flow Meters

Same basic principles, but entire revamping of design, characterize new Republic flowmeter line. Design changes in method of assembling actuating elements. "Cartridge - sealed element," is new actuating unit built into metal cartridge ready for mounting on instrument panel and easily interchangeable. Used on three types of instruments, indicator, recorder, and integrator, which in new design extend above panel only 1 in. Pen adjustment automatically lifted from chart when chart knob is unscrewed. Integrator independent of clock and other instruments.

New boiler horsepower indicator, "CS-24," has 24-in. porcelain enamel dial with large white figures on black field.

Republic Flow Meters Co., 2222 Diversey Pkway., Chicago, Ill.

POWER LINES

Problems in Refrigeration and Air Conditioning to Be Presented to A.S.R.E.

The technical program announced for the 29th Annual Meeting of The American Society of Refrigerating Engineers, which will be held Dec. 6, 7 and 8 at the Hotel New Yorker, New York City, includes papers on some of the most recent problems arising in the swift-moving fields of refrigeration and air conditioning. The physiological side of air conditioning, the operation of air conditioning in a rayon plant, a new insulation of expanded rubber which is manufactured only in England, and in small quantities, methods of passenger car cooling and food load tests in domestic refrigerators are some of the subjects. A feature of the technical program is the joint air-conditioning session on Thursday afternoon, Dec. 7, with the A.S.M.E. in the Engineering Auditorium at 29 West 39th St., New York.

Papers include:

"Expanded Rubber Insulation," H. D. Edwards, Union Carbide Co.

"Applications of Vacuum Systems," F. D. Berkeley, Ross Heater & Mfg. Co.

"Coordination of Research and Engineering with Production and Sales," J. S. Beamensderfer, research engineer, York Ice Machinery Corp.

"The Condenser Water Problem," Walter L. Fleisher, consulting engineer.

"Standards of Measurement in Refrigeration," A. B. Stickney, Fred Ophuls & Associates.

"Thermodynamics of SO_2-Oil Systems," L. A. Philipp, director of research, Kelvinator Corp.

"The Mercury Compressors; New Designs," J. C. DeRemer.

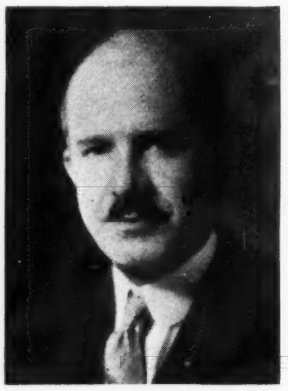
"Psychrometric Investigations and Data," F. G. Keyes, Massachusetts Institute of Technology.

"Physiological Side of Air Conditioning," R. R. Sayres.

"Noise Elimination and Air Motion," C. Graves.

"Operation of Air Conditioning in Rayon Manufacture," W. C. Giles, The Viscose Co.

"Unit Equipment for Restaurants, Offices and Stores," W. C. Goodwin, Supply Engineering Dept., Westinghouse Electric & Mfg. Co.



Alexander R. Stevenson, Jr., of General Electric, vice-president of the A.S.R.E. and nominee for president

Save $100,000 by Moving Boiler Plant 400 Miles

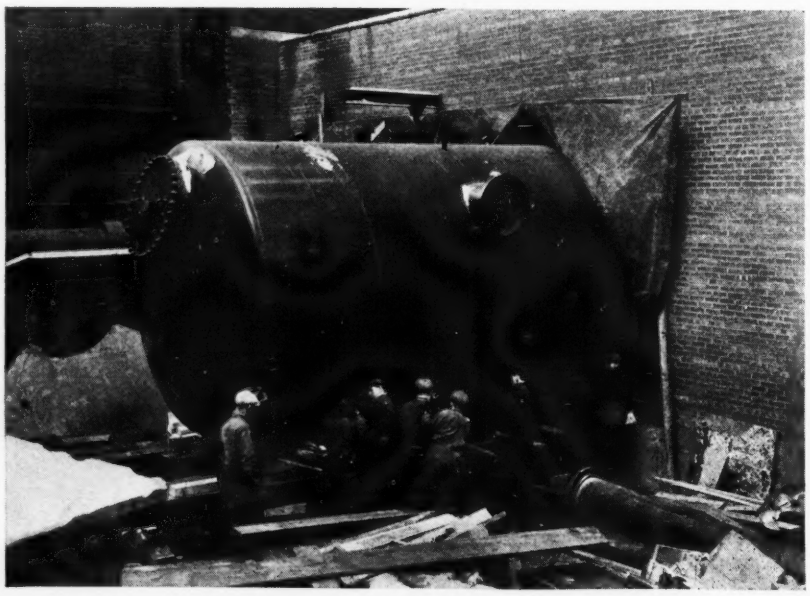
Six 8,170-sq.ft. Stirling boilers with underfeed stokers will be transferred from the U. S. Naval ordnance plant at Charleston, W. Va., to Washington Navy Yard to replace 15 obsolete A & T type B & W boilers (built for 160 lb. without superheat) for general steam requirements at this important station. The cost of the work will be about $310,000, including various modernization activites allied with it, representing a saving of about $100,000 over the cost of purchasing all new equipment. The Charleston boilers were installed prior to the World War, but were never used in regular service as the plant was not operated for any length of time by the government. The boilers will be taken down and shipped by rail to Washington, the work involving cutting out some 4,000 tubes which it is planned to anneal in an oil furnace at the Navy Yard before reinstallation. They can supply steam to the yard at 250 lb. and 100 deg. F. superheat.

New steel to support the boilers at Washington will be required at an estimated cost of about $20,000. An order for air-cooled wall construction with carborundum facing around the stoker area has been awarded to American Arch Co., New York, for about $30,000. The stokers at Charleston are to be remodeled by Westinghouse and equipped with clinker grinders, the estimated cost of modernizing being about $80,000. For forced-draft service, six Sturtevant fans will be supplied, each being driven by a steam turbine through reduction gearing and by a 50-hp., variable-speed, 220-volt, D.C. Westinghouse motor. The cost of the fans will be about $6,000 and of the motors and turbines, about $20,000. Present boiler feed pumps will be used. The job also includes an ash removal system of the hydraulic type, with a 150-hp., 220-volt, induction motor driving a centrifugal pump with a capacity of 1,140 gal. per min. at 305-ft. head. Superheater Co. has been awarded a contract for superheaters, and single-pass baffling will be used. Another contract with Permutit Co. provides for installation of a blow-down system and "Ranerex" CO_2 recorders, one per boiler, at a total cost of about $8,000. Carrick combustion control will probably be used.

Schenectady Mercury-Steam Begins Preliminary Operation

Preliminary operation of its new outdoor 20,000-kw. mercury-vapor turbine generator at Schenectady was started by General Electric Co. late in October. This new generating station, which will be leased to and operated by New York Power & Light Corp., will supply electricity for the power company's transmission system and steam for use in the General Electric factory. In addition to the by-product output of 330,000 lb. of steam per hr. from the mercury condenser, the station also includes a steam boiler to supply 300,000 lb. of steam per hr. That boiler was placed in regular service during the summer.

GIANT DEAERATING HEATER FOR GOODYEAR



Work on Goodyear's half-million dollar power plant construction is progressing steadily—and here's the latest arrival among a group of tanks to be used in connection with the water-softening and heating units. A de-aerating heater, it weighs 25 tons, is 25 ft. long and 13½ ft. high. When working, this big fellow will heat 32,000 gal. of water per hour, will weigh more than 53 tons. Brought to Akron on a flat car, the giant tank had to be routed by a roundabout way because not all railroad bridges could provide the necessary clearance for car and load to pass.

A.S.M.E. Meeting in Full Swing

At the time this issue is mailed the annual meeting of the American Society of Mechanical Engineers is in full swing in the Society headquarters, 29 West 39th St., New York, N. Y. It will continue until Dec. 8. As usual, *Power* will present the first complete abstract of papers of interest to power men in its Mid-December number, which will be mailed approximately Dec. 20. High points in the technical program include symposiums on heat transmission and water measurement, papers on co-operation between industrial and public utility power plants, and management problems of industrial recovery. A joint session with the American Society of Refrigerating Engineers and the A.S.M.E. Process Industries Committee, will be devoted to air conditioning.

The Henry Robinson Towne lecture on the relation of engineering and economics will be delivered by David Cushman Coyle, consulting engineer of New York.

National Electrical Code Revised

Changes in regulations covering services and service equipment, conductors, wiring-installation design, and emergency lighting are among the major revisions in the forthcoming 1933 edition of the National Electrical Code. Following are major revisions:

Article 1: Definitions—A number of changes were made so as to secure conformity with the new proposed American Standard Definitions of Electrical Terms, ASA Project C42.

Article 4: Services and Service Equipment—A multiple tenant building may now have more than a single set of service conductors and service equipment. The omission of insulation on grounded neutral service conductors is permitted for a greater variety of conditions, first recognition of this practice having been recorded in the 1931 text. Similarly, the limitations upon the use of unfused meters placed ahead of the service switch are relaxed somewhat.

Article 6: Conductors—Provision is made for a flame-retarding as well as a moisture-proof finish on single-conductor circuit wires.

Article 8: Automatic Overcurrent Protection of Circuits and Appliances—A new type of so-called non-tamperable plug fuse is recognized.

Article 9: Grounding—The regulations for protective grounding are completely rewritten. Technical changes include wider permitted use of artificial grounding electrodes and, with certain restrictions, the interconnection of a distribution primary lightning-arrester grounding conductor with a grounded-neutral service conductor.

Article 20: Wiring Installation Design—This is a new chapter, much of its text taken from other articles of the previous edition. It seeks to treat adequacy problems of wiring and outlets. It is not settled just when requirements seeking to obtain adequacy for expected future use are beyond the police power. The new provisions are conservatively stated, partly with this doubt in mind.

Article 41: Emergency Lighting—Provisions, formerly in Article 36, for theaters and the like, have been transferred to this article, which is new, and a general treatment of emergency- and exit-lighting problem (electrically) is worked out.

Article 50: Circuits and Equipment Operating at More Than 600 Volts—Much of the change in this article is because of transfer of former text to the chapter on Signs and Outline Lighting and to new Article 51 on X-ray and High-Frequency Apparatus. For power circuits the recognized use of high-voltage fuses has been extended. Clearances, both horizontal and vertical, above floors and from working spaces, or live parts at various voltages now appear in table form.

Norris Dam Begun 1½ Months Early

More than a month and a half ahead of schedule, construction work on the Norris Dam itself has begun. The first coffer dams are being installed for unwatering the bed of the Clinch River. As soon as these are completed, work will begin on dam foundations. Preliminary calculations had set Jan. 1 as the date when work would get under way.

Three test tunnels to determine the nature of the great dam's foundations have been completed.

The engineer and construction superintendent for the General Joe Wheeler Dam, 15½ mi. upstream on the Tennessee River from Wilson Dam, have been appointed and are already on the job at Muscle Shoals. This dam will be more than a mile in length and will rise 50 ft. above the present river level, impounding water for a distance of approximately 88 mi. and submerging the last ledges of the Muscle Shoals.

POWER NOTES

At a meeting of dealers in used machinery, held in Chicago Saturday, Oct. 21, a national organization was formed to be known as The National Institute of Used Machinery & Equipment dealers. Officers elected are D. D. Galbreath, pres. (Marr-Galbreath Co., Pittsburgh), S. A. deWitt, vice-pres. (DeWitt Tool Co., New York City), C. L. McDonald, treasurer (McDonald Machinery Co., St. Louis). Executive offices are to be located in Pittsburgh. Dealers attending are from St. Louis, Chicago, Detroit, Pittsburgh, Philadelphia, New York and other sections of the country. Membership in the Institute is open to dealers in all classes of used machinery and equipment.

Vancouver, B. C., is planning central heating plant, to be owned by Harry A. Flood, of Tacoma, Wash. A franchise is to be voted on at the Dec. 13 civic elections. Areas to be served contain approximately 100,000,000 cu.ft. of office and store space. The initial outlay would be between $150,000 and $250,000.

THE MERIAM CO., 1955 West 112th St., Cleveland, Ohio, has offered to give, free, one of its latest type cleanout "manometers" to colleges and other educational centers having engineering courses. During a similar offer, in the spring of 1930, the company gave away 165 standard U-tube manometers.

BREVITIES

OTTO J. MYER, previously mechanical superintendent of Atlantic Coast Fisheries Corp., New York, has become plant engineer of Narragansett Brewing Co., Providence, R. I. Some time ago he was with General Electric as erecting engineer.

H. J. ACHEE, formerly in charge of the Scott City, Kans., municipal light plant, has become superintendent of the Paris, Ky., municipal diesel plant.

A. E. GROVE has been transferred from the Cleveland office to the Chicago office of Steel & Tubes, Inc., 224 East 131st St., Cleveland, Ohio. R. E. Doyle becomes sales correspondent, Cleveland office, and J. F. Keeler, sales engineer, with headquarters in Cleveland.

WHITING CORPORATION, Harvey, Ill., will manufacture stokers for the Master Heating Co., La Fayette, Ind., to be known as "Master" units, of 25 to 500 lb. per hour capacity.

MCINTOSH & SEYMOUR CORP., Division of American Locomotive Co., Auburn, N. Y., has opened a New England sales office at 88 Broad St., Boston, Mass.

OBITUARIES

THOMAS BRENNAN, chief engineer and superintendent of buildings for R. H. Macy & Co., New York City, for the past 47 years, died at his home, 556 West 170th St., Nov. 5 of pneumonia. He was born in Castle Comer, County Kilkenny, Ireland, April 15, 1857.

Mr. Brennan has been a licensed engineer for the past 55 years and held license No. 1, being the oldest licensed engineer in New York City. He was chief engineer of the old Booth Theatre and later chief engineer of St. Vincents Hospital, which he left to become chief engineer for R. H. Macy in the old store on 14th St. Macy's old store had one of the first isolated plants in the City, which consisted of three Ball and Wood engines driving four Edison bi-polar generators by belt, two being 100-kw., one a 60-kw. and one a 40-kw. unit. Mr. Brennan supervised construction of the new building when Macy's moved from 14th St. to 34th St. The 34th St. store was enlarged several times and the generating plant with it until now the plant he was chief of until his death comprises: One 250-kw., four 400-kw. and two 750-kw. electric generators operated by

steam-driven reciprocating engines, one 1,000-kw. generator driven by low-pressure steam turbine and two 800-kw. generators driven by diesel engines.

T. HUBERT CLEGG, of Philadelphia, assistant to Llewellyn Evans, electrical engineer in charge of operations at Muscle Shoals was killed Nov. 20 in an automobile accident.

SAMUEL RYNN MORROW, SR., manager of the Birmingham office of Chain Belt Co., died Oct. 29, when he contracted pneumonia after an apparently successful appendicitis operation earlier in the month.

FREDERICK BRITTEN SAGE, for 31 years connected with the New York office of Cochrane Corp., died Oct. 30. He graduated from Lehigh University in 1893 and was engaged in electrical work until 1902, when he joined the staff of F. E. Idell, at that time Cochrane representative in New York.

FEDERAL ALLOTMENTS

Recent non-federal allotments for power equipment announced by Public Works Administrator Harold L. Ickes, include:

Loan and grant, $67,000 to Massachusetts for installation of two 3,600-sq.ft. boilers with appurtenances and necessary structural pipe changes in existing power house at State Prison Colony, Norfolk, Mass. Thirty per cent of the cost of labor and material, which totals approximately $53,200, is a grant.

Loan and grant of $160,000 to Shelby, Ohio, for construction of a new building and installation of a 1,500-kw. turbo-generator, complete with condenser and all auxiliaries. Thirty per cent of the cost of labor and material, which totals approximately $128,000, is a grant.

Loan and grant of $12,000 to the Board of Education, Carrolton, Ky., for installation of a modern steam plant in existing school building. Thirty per cent of the cost of labor and material, which totals approximately $11,300, is a grant.

Grant of $25,000 to Blue Earth, Faribault County, Minn., to aid in installation of new power house equipment, including boiler and 500-kw. turbo-generator unit. No loan requested. Allotment represents 30 per cent of cost of labor and material on project, of which total cost is $101,000.

Loan and grant for $738,000 to Fort Collins, Larimer County, Colo., for construction of a 4,000-kw., steam-electric generating station and an electric distribution system, or purchase of existing system from Colorado Public Service Co. Thirty per cent of the cost of labor and material, which totals approximately $511,000, if new distribution system is constructed, or $303,000 if system is purchased, is a grant.

Grant of $25,000 to Chanute, Kans., to aid in installation of a 2,500-kw. turbine and generator, condenser, circulating pump, steam piping, spray-pond piping, and other necessary auxiliaries. No loan requested. Allotment represents 30 per cent of cost of labor and material on the project, of which total cost is $87,972.

Allotment of $80,000 additional to aid in reconstruction of power plant at St. Elizabeth's Hospital, Washington, D. C. Original authorization for this project was $250,000.

Loan and grant of $140,000 to Georgetown, Vermillion County, Ill., for construction of complete water-works, filtration plant and distributing system. Thirty per cent of cost of labor and material, which total is $100,000, is a grant.

Loan and grant for $32,000 to Albion, Ind., for use in installation of a 300-kw. turbo-generator, spray pond, and 100,000-gal. elevated water tank. Thirty per cent of cost of labor and material, which totals approximately $29,000, is a grant.

Loan and grant for $200,000 to Bristol, R. I., for construction of three sewage pumping stations, an intercepting sewer and sewage treatment plant. Thirty per cent of cost of labor and material, which totals approximately $132,000, is a grant.

Loan and grant of $29,000 to the Board of Public Utilities of Kansas City, Kans., to aid in water-works improvement, including construction of elevator storage tank, booster pumping equipment, distribution system. No loan requested. Allotment is 30 per cent of cost of labor and material under a total cost of $117,874.

Escondido, Calif., has authorized financing through Federal loan and grant for a municipal electric light and power plant, totaling $260,000, including distributing system. Early construction planned. J. H. Chase, Civic Center Bldg., Los Angeles, Calif., consulting engineer.

RAYMOND WILCOX, mechanical engineer of the fuel-electric generation department, Southern California Edison Co., has been elected president of the Engineers' Club of Los Angeles, Calif., for 1933-34. He succeeds Charles S. Howe, president of the Los Angeles Testing Lab., Inc. Other officers are Frank F. Boyd, consulting marine engineer, first vice-president; H. W. Hitchcock, chief engineer, Southern California Telephone Co., second vice-president; Edwin F. Stauffacher, electrical engineer, Southern California Edison Co., secretary, and W. R. Clifford, chief engineer, Layne & Bowler Pump Corp., treasurer. New directors of the club are Mr. Howe, W. Roy Shettle, engineer in charge of construction, Los Angeles Gas & Electric Corp.; Lloyd Aldrich, city engineer, City of Los Angeles, and Ezra B. Rider, experimental engineer, Metropolitan Water District of Southern California.

STRAWS

Pointing the way the business wind blows

Several Texas municipalities have plans under way for new electric light and power plants. Financing is being carried out with Federal aid. They include: Fort Worth, cost close to $4,000,000, with equipment, including distribution site on West Seventh St.; Albert B. Vickery is city utility engineer, in charge. Booker, light plant in conjunction with a new city-owned ice plant, entire project to cost about $35,000; financing is under way. Dalhart has surveys and estimates of cost in progress. Bartlett proposes a fund of $60,000, preliminary plans are under way. Brownsville plans extensions and improvements, appropriation about $200,000 for this and other municipal utilities, including water-works and drainage system. Plainview has recently taken bids for plant to cost $423,000; bonds in amount of $450,000 have been made available; installation will include three diesel engine-generator units, with complete auxiliary equipment, as well as distribution system; Montgomery & Ward, Wichita Falls, Tex., consulting engineers for this project. Goose Creek has completed plans for a station to cost $125,000; David M. Duller, Houston, Tex., is consulting engineer. Wink is arranging financing for $95,000, of which about $40,000 will be expended for a plant, remainder for municipal water-supply system.

Yellowstone Irrigation District, Hysham, Mont., B. C. Lillis, 239 Clark Ave., Billings, Mont., consulting engineer, has plans under way for new irrigation system, for which a Federal loan of $175,000, has been approved. A large electric-operated pumping station will be built at Myers, Mont., and transmission line constructed from Hardin, Mont., where power supply will be secured.

Columbia Basin Commission will award the principal contract for Coulee dam about May 15, 1934. Ellsworth C. French, research director, predicts that preliminary work costing $5,000,000 and employing 1,500 men will be under way shortly and will include: engineering camp, $500,000; bridge to be used during construction, $650,000 to $700,000; preliminary excavations, $2,000,000; highways, $750,000; railway extension, $750,000. The Washington Water Power Company has agreed to extend a line from Coulee City to the dam site, to provide 6,000 to 10,000 hp. for construction purposes.

Verde River Irrigation and Power District, Security Bldg., Phoenix, Ariz., B. C. Clingan, president, has secured an initial fund of $4,000,000 through Federal loan for proposed power project. Estimated to cost $18,912,000 and additional appropriations will be secured as work progresses. Program will include construction of three main power dams, to be known as the

Camp Verde, Horseshoe and Bartlett, with and one standby power plant. The Camp Verde dam will cost $3,190,591, power plant $634,200; Horseshoe dam will cost $1,623,775, and power plant, $225,745; and Bartlett dam, $310,350, and generating station, $200,000. Work will include a transmission system to cost $960,000, and power substations estimated at $250,000, with equipment.

SOUTH

The planned municipal hydro-electric plant is to be constructed on Little River near Radford, Va., at a cost of approximately $146,000. The Radford city council, upon being informed that the Federal power commission had issued a license for the plant, promptly met and awarded contracts for building the dam and contracting and equipping the power house.

Votes of Decatur and Oneonta, Ala., increased to eleven the number of Alabama cities favoring municipal operation of electric power plants. Other towns are: Sheffield, Florence, Tuscumbia, Muscle Shoals, Muscle Shoals City, Guntersville, Martinsville, Tarrant City, Bessemer and Andalusia. Birmingham and Homewood rejected the proposal.

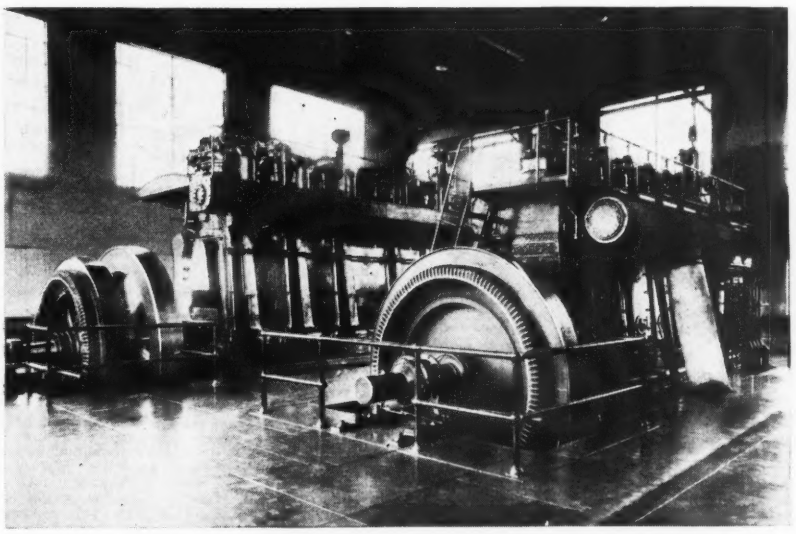
The application of Culpeper, Va., which has been in dispute as to whether power interests were hindering approval, has been approved by Secretary Ickes. A grant to the city of $125,000 has been authorized, representing 30 per cent of the cost of building the proposed plant, and a loan of $45,000 has been issued.

Formulation of a government contract for construction of a $3,000,000 municipal hydro-electric plant for Danville, Va., is still being held up. Funds have already been made available for a loan and grant from the Federal Public Works Administration. Loan and grant were approved Oct. 11.

City officials of Greenville, S. C., are giving serious consideration to a plan that may provide the municipality with its own gas and electric plant. An application will be filed shortly, according to Mayor John McH. Mauldin, for money from the Federal public works act to construct such a plant.

EAST

Atlantic Pipe Line Co. has purchased seven 340-hp. Cooper-Bessemer engines for pipe-line service.



Two of the engines of the Lubbock, Texas, municipal plant. In the foreground is a 6-cyl. Nordberg diesel driving a 1,250-kva. generator. The other is a 5-cyl. Nordberg diesel driving a 1,125-kva. generator, installed several years ago

Austin Dam, Inc., has requested the Austin-Texas City Commission to grant a two-year extension from Nov. 28 for starting work of rehabilitating the dam across the Colorado River and the hydro-electric plant at Austin. To cost $40,000.

A new company is being organized by Osage County, Okla., interests, represented by T. C. Hughes, 1626 South Baltimore St., Tulsa, Okla., consulting engineer, to construct and operate a hydro-electric generating plant on the Arkansas River, near Kaw City, Osage County, to serve in radius of 80 mi. Plant will be equipped for an initial capacity of 30,000 hp., designed to provide for additional generating units at later date. Program will include construction of an extensive transmission system. Entire project to cost close to $2,000,000, and application has been made to the State Department of Power, Waterways and Flood Control, Oklahoma City, for necessary financing.

Weida Candy Co., Paterson, N. J., has purchased a Buda diesel power plant from John Reiner & Co., New York City.

Huntington, L. I., N. Y., Water District has ordered a 100-hp. diesel from American Diesel Engine Co. The engine, running at 1,400 r.p.m., is to be direct-connected through bevel gears to a deepwell turbine pump.

Chambersburg, Pa., will install a 2,500-kw. turbo-generator unit with accessories. A fund has been secured.

Plans have been authorized by the State Department of Correction, Boston, Mass., for a new electric generating plant at State Farm, Bridgewater, Mass., to cost over $100,000. Boston State Hospital will also make a $350,000 power plant addition.

Minoa, N. Y. (William T. Costello, president of the village board), is planning a municipal plant.

Shadyside, W. Va., is considering a municipal light plant. Fairbanks-Morse has submitted an offer.

The Hotel Chelsea automatic diesel installation involving three old 50-kw. diesels, and the power plant of Sigmund-Ullman Division, General Printing Co., involving two 300-kva. units, have been closed down and purchased power has been substituted. Both plants are in New York City.

MIDWEST

Glenwood, Minn., has sanctioned a bond issue of $140,000 to finance a new municipal light and power plant.

Dowagiac, Mich., voted in favor of municipal light plant to cost $202,000.

Eveleth, Minn., voters have favored a municipal light and power plant with federal loan, if obtainable.

Cicero, Ind., has retained Thomas Waynne Co., Indianapolis, Ind., to prepare plans for a municipal light plant.

Hastings, Nebr., has authorized Black & Veatch, Kansas City, Mo., for a survey of a proposed municipal light and power plant.

Enderlin, N. D., has voted favorably on a $100,000 municipal light and power plant, to be diesel-operated. A federal loan has been requested.

Mountain Lake, Minn., has purchased two diesel engines and auxiliary equipment to cost approximately $45,000, from Fairbanks, Morse & Co.

Wisconsin Veterans Home, Waupaca, Wis., is planning a new power plant to cost $200,000.

Detroit Edison Co. has been installing a 50,000-kw. turbo-generator in Delray power-house No. 3. The machine went into service Oct. 20.

Lamoni, Iowa, has authorized plans for a municipal electric light and power plant, using diesel engine-generator units, estimated to cost about $100,000, with equipment. Proposed to arrange financing at early date. Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer. The same engineer is preparing a report and making surveys for a similar generating plant at Oskaloosa, Iowa, to cost approximately a like amount. This municipality will carry out financing as soon as plans are completed.

Trenton, Mo., is completing financing for $250,000, for new municipal electric light and power plant and distribution system. Proposed to begin work before the close of year. Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

La Junta, Colo., will make surveys and estimates of cost for a municipal light plant and proposes special election; preliminary estimates in excess of $100,000, with equipment; Franklin P. Wood, 1441 Welton St., Denver, Colo., consulting engineer. La Salle, Colo., has made application for a Federal loan of $60,000 for a municipal plant, and will begin work as soon as fund is assured.

State Board of Control at Madison, Wis., is planning a power plant at Northern Wisconsin Training School, Chippewa Falls, to cost $240,000.

New Bulletins

Humidity Instruments—Amthor Testing Instrument Co., Inc., Brooklyn, N. Y. Bulletin No. 108; hydrometers, recorders and other instruments for accurate determination of true air conditions.

Electricity at Work—Electric light and power industry at a Century of Progress Exposition, Chicago. Bulletin in color describing this exhibit from Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.

Belt Idlers—The Jeffrey Mfg. Co., Columbus, Ohio. Bulletin No. 569, 12 pages, on Reliance belt idlers.

Boiler Setting—Plibrico Jointless Firebrick Co., 1800 Block on Kingsbury St., Chicago, Ill. Eight-page bulletin on Plibrico steel-cased setting.

Valves—Jenkins Bros., 80 White St., New York City. Catalog No. 23, 264 pages, covers 400 Jenkins valves, complete details and other data.

Water-Gas Generator Furnace Linings—McLeod & Henry Co., Troy, N. Y. Four-page bulletin G-164 shows how to line water gas generator furnaces.

Flow Meters — Schutte-Koerting Co., Philadelphia, Pa. Bulletin on Rotameters for liquids and gases previously described.

Combustion Gas Burners—Lee B. Mettler Co., 406 S. Main St., Los Angeles, Calif. Fifty-page bulletin on burner specifications, installation drawings and combustion engineering data.

Gages, Valves, Industrial Heating Equipment—Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill. General catalog on these subjects.

Pump Head—Peerless Pump Division, Food Machinery Corp., Los Angeles, Calif., and Massillon, Ohio. Bulletin showing Peerless standard hollow-shaft motor construction, MoTurbo head, and full floating direct-connected heads for use with motors up to 500 hp.

Cast Iron Pipe & Fittings—Central Foundry Co., 420 Lexington Ave., New York City. A 56-page booklet; Universal cast-iron pipe and fittings and Dual-lok joint cast-iron pipe and fittings, 2 to 30-in. diameters. Also cement-lined.

Screw Conveyor—Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. 128-page Data Book No. 1289 on Caldwell Helicoid and Sectional-Flight Screw Conveyor.

Westinghouse—Recent Westinghouse bulletins include eight-page leaflet 20565 on oil circuit breakers; Leaflet 20537 on Type G high-speed synchronous motors; Leaflet 20584 on splash- and drip-proof drives; Leaflet 20588 on new De-Ion Type DA power fuses.

Refractories—Standard Fuel Engineering Co., Detroit. Six-page folder on "Zero" refractory products.

Spiral Pipe—Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill. A 63-page catalog on Taylor spiral pipe, riveted or welded.

Spray Cooling Towers—The Marley Co., Kansas City, Mo. Bulletin No. 41, "Marley Forced-Draft Spray Cooling Towers, 16 pages, typical installations and types of units.

Pressure Control Instruments — Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass. Bulletin No. 200-c, "Mason-Neilan Compensated Pressure Control Instruments," 24 pages, includes data on parabolic gradual-opening ball-bearing control valves.

Control Valves—W. H. Nicholson & Co., Wilkes-Barre, Pa. Bulletin No. 933, 4 pages, "Nicholson" 2-, 3- and 4-way multi-port and distributing valves for steam, air, oil, tar or water. Pressures up to 300 lb.

Air Filters — Owens-Illinois Glass Co., Toledo, Ohio. Folder "Dustop" glass-wool air filter, its method of installation, and glass blocks for exterior and interior walls.

Diesel Engines — McIntosh & Seymour Corp., Auburn, N. Y. Bulletin No. 151, 28 pages, typical installations, constructional details, types and sizes on stationary diesel engines.

Steam-Jet Vapor Refrigeration Units—Ingersoll-Rand Co., Phillipsburg, N. J. 12-page bulletin, "Steam-Jet Vapor Refrigeration Units," gives technical data and list of Ingersoll-Rand offices.

Feed Water—D. W. Haering & Co., Inc., 3408 West Monroe St., Chicago, Ill. 16-page bulletin, "H-O-H," water problems and methods of treatment.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ariz., Tuscon—City plans new diesel engine power and light plant. Burns & McDonnell Eng. Co., 107 West Linwood Bld., Kansas City, Mo., engrs.

Calif., Selma — Municipality plans electric power plant (diesel) for waterworks and pumping power plant, $57,000: 300,000 gal. water tank, tower, etc., $106,000. E. K. Hussey, Syndicate Bldg., Oakland, engr.

Colo., LaSalle — City made application for P.W.A. loan to finance construction municipal light and power plant. $60,000.

Ill., Aurora—City plans extending and improving waterworks system, incl. pumps, water-main extensions, fire hydrants. $450,000.

Ill., Cave-In-Rock—City plans municipal light and power plant, waterworks and distribution system. $800,000. Russell & Axon, 229 Roosevelt Bldg., St. Louis, Mo., engrs. Will ask loan and grant under P.W.A.

Ill., Chester—City plans municipal light and power plant. $158,000. Applied for loan under P.W.A. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., consult. engrs.

Ia., Corning — City plans 675 hp. electric light plant including generator units, switchboard and distribution system, three 225 hp. Diesel engines, three 150 kw.-ac. generators, $144,200. Young & Stanley, Inc., Muscatine, engrs.

Ind., Albion—City plans waterworks improvements, incl. 3,300 kw. turbine generator, 100,000 gal. elevated tank, constructing spray pond. $32,000. P.W.A. loan granted. L. A. Geupel, Indianapolis, engr.

Ind., Fortville—City, L. Barrett, clk., plans power plant. $65,000. J. Duzan, Fortville, chn. Town Bd. P.W.A. project.

La., Coushatta — City preliminary surveys being made municipal light plant and waterworks system. $100,000. Application will be made for P.W.A. loan. P. P. Stephens, Jr., mayor.

Mass., Northampton—Bids Dec. 7, by Commonwealth of Massachusetts, Dpt. Mental Diseases, State House, Boston, power plant at State Hospital, incl. heating, plumbing, electrical work, boilers, stokers, coal handling machinery, etc., $360,000. Edward C. Brown Co., 77 Summer St., Boston, engrs.

Mich., Dowagiac—City making plans municipal electric light and power plant. $200,000. Norris-Ayres Co., Ann Arbor, consult. engrs. Application to be filed for Federal aid in financing under P.W.A.

Mich., Pontiac—City, W. P. Edmonson, mgr., City Hall, plans power plant, incl. steam driven generating equipment. $316,000. Will apply for P.W.A. loan.

Mich., Wahjamega—Michigan State Hospital for Epileptics, granted tentative approval by P.W.A. for loan to construct group of hospital buildings, incl. power plant, laundry, shops, fire protection and water supply. $1,240,000. Dise & Hoffman, 2631 Woodward Ave., Detroit, archts.

Minn., Blue Earth—City, J. J. Kehr, clk., plans alterations to electric light and power plant. $90,000. P.W.A. allotted $25,000 grant. R. D. Thomas, 1200 2nd Ave. S., Minneapolis. engr.

Mo., Belton—City plans power and distribution system. $60,000. Will ask loan and grant under P.W.A. E. T. Archer & Co., 609 New England Bldg., Kansas City, engrs.

Mo., California—City plans light plant, $135,000. Applied for loan and grant under P.W.A. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, engrs.

Mo., Centralia—City making plans reconstructing present power plant building and installing new equipment. $105,000. Will apply for loan under P.W.A. Burns & McDonnell Eng. Co., 107 Linwood Bldg., Kansas City, engrs.

Mo., Concordia — City making plans light plant. $70,000. Filed application with State for $19,000 grant. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, engrs.

Mo., Macon—City, C. O. Powell mayor, plans extending light and power plant and waterworks, $178,000. Applied for $48,200 grant and $129,180 loan under P.W.A. Baumes-McDevitt Co., 1871 Railway Exch. Bldg., St. Louis, engrs.

Mo., Moberly—City plans power and light plant and distribution system. $700,000. H. W. Thomas, Jr., city engr. Applied for loan under P.W.A. Noted Sept. 28.

Mo., Parma—City plans waterworks system, incl. deep well, 75,000 gal. tank tower, 7,000 ft. watermains, reservoir, pump house, pumping equipment, etc., $45,128. Applied for $33,700 loan and $11,300 grant under P.W.A. Russell & Axon, 4903 Delmar Blvd., St. Louis, engrs.

Mo., Potosi—City plans municipal light and power plant. $64,000. Applied for $50,000 loan and $14,000 grant under P.W.A.

Mo., Stanberry—City making plans municipal light plant. $98,000. Henrici Lowry Eng. Co., 114 West 10th St., Kansas City, engrs. Applied for P.W.A. loan.

Mo., Trenton — City making plans power plant. $250,000. Henrici Lowry Eng. Co., 114 West 10th St., Kansas City, engrs.

Neb., Gering—City Council retained C. R. Fulton, 2327 South 19th St., Lincoln, to prepare plans and specifications municipal light and power plant, incl. improving building, diesel engine generating units, switchboard, auxiliary equipment. $65,000. Made application for grant and loan under P.W.A.

Neb., Hastings—Municipality plans electric power plant addition. $28,000. P. T. Naylor, engr.

Neb., Sutherland — Platte Valley Reservoirs Assn., H. L. Williams, pres., Gothenburg, plans dam and hydro-electric power plant, on south Platte River, near here, together with canal from North Platte River 3 mi. west of Keystone to Sutherland dam site with syphon under South Platte River and return canal to river, etc. Total $4,805,877. P.W.A. approved loan. D. D. Price, 321 Terminal Bldg., Lincoln, engr.

Nevada—Bids Dec. 15, by Bureau Reclamation, Denver, Colo., ten 23,000 volt, 4,000 ampere, and two 15,000 volt, 2,000 ampere, vertical lift type or removable truck type oil circuit breakers, each complete with all accessories for installing Boulder Power Plant, Boulder Canyon Project, Arizona-California-Nevada. E. Mead, comr.

N. H., Durham—University of New Hampshire, E. M. Lewis, pres., plans electric generating plant at University. $30,000 or more. P.W.A. project. Architect not appointed.

N. J., Camden — Voted $10,000,000 for municipal power plant.

N. J., Newark—Bd. City Comrs., A. F. Minisi, dir., City Hall, plans power house, Passaic River. $1,000,000. Seeking P.W.A. funds. Architect and engineer not appointed.

N. Y., New York—Bids Dec. 19, by Vet. Bu., Arlington Bldg., Wash., D. C., new boilers and boiler plant equipment at Veterans' Administration Facility.

N. Y., Tarrytown—Bd. Water Supply plans electric power plant. $200,000. Will ask $15,000 loan under P.W.A. $50,000 available.

O., Columbus—Voted $824,000 for municipal light plant extension.

O., Mogadore—Village made application for Federal loan to finance construction light plant and distribution plant. $65,000. P. W. Elwell, 4300 Euclid Ave., Cleveland, city engr.

O., Sandusky—Voted $1,400,000 for municipal power plant.

O., Shelby—City, B. Fix, Clk., plans by Froelich & Emery, engrs. and archts., 2nd Natl. Bldg., Toledo, light plant addition, consisting of new turbine, costing $160,000 and building to house same $30,000. P.W.A. project.

Okla., Geary—City sketches made municipal electric light plant. $65,000. J. C. McKeel, Geary, engr.

Okla., Muskogee—City plans municipal electric light plant. Applied to P.W.A. for $1,260,000 loan. T. P. Clouts, city engr.

Pa., Fleetwood—Boro Council, voters approved $115,000 bond issue for construction municipal electric light and power plant. P.W.A. project.

R. I., Kingston—Rhode Island State College, R. G. Bressler, pres. Bd. Mgrs., plans power plant at State College. $100,000.

S. D., Freeman—City plans municipal electrical power and distribution plant. $72,000. Federal funds to be sought. Buell & Winter Eng. Co., 503 Insurance Exch. Bldg., Sioux City, Iowa, engrs.

Tex., Brownsville—City, c/o R. B. Renfro mayor, plans reconstructing waterworks system, electric light plant, etc. $200,000. Loan approved by P.W.A.

Tex., Hillsboro—City rejected bids new engines for light and power plant. Will readvertise soon.

Wis., Chippewa Falls—State Bd. Control, A. W. Bayley, secy., Madison, plans by A. Peabody, Madison, power plant at training school. $248,000. P.W.A. has agreed to finance construction.

Wis., LaCrosse—Bd. Normal Regents, E. G. Doudna, secy., Madison, plans by A. Peabody, Capitol, Madison, heating plant at State Normal School. $81,700. P.W.A. agreed to finance construction.

Wis., Lancaster—City, D. Crichton, clk., making sketches water pumping station to force water supply 3 mi. into city. A. H. Martin, Prairie du Chien, engr.

Wyo., Gilette — Black Hills Power Assn., Gilette, applied for P.W.A. loan for construction steam power plants and distributing electrical power in Wyoming and South Dakota. $8,000,000.

POWER

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PHILIP W. SWAIN, *Managing Editor*

MID-DECEMBER, 1933 Volume 77, Number 13

ONCE again, in the name of POWER and of all who have to do with its management and making, I am privileged to wish to all to whom these presents may come a Merry Christmas and a Happy New Year.

For a time attention is diverted from routine and personal pursuits to thoughts of what can be done to add to the pleasure of the Christmas season for others:

To make this break in the mingled whirl and humdrum of the year a time of real festivity, the Christmas of Dickens, of glad hearts glowing with Good Will Toward Men.

From the tot who has still to suffer the disillusionment of Santa as a real living being to those who have come to realize his existence in the spirit which pervades this season of concern for others, may there come to all a full measure of happiness and of good cheer.

To the victims of poverty and misfortune the generous impulses induced by the Christmas Spirit bring a seasonal respite from their privations, a gleam of sunshine and a touch of human fellowship. May the revelation of their necessities result in their lasting amelioration.

The Great Reformer whose birth we celebrate did not say, "The poor ye will always have with you." The earth in its fulness has enough for all. It is a tragic paradox in our social-economical system that the increasing ease of the adaptation of natural resources to human use should result in the reduction of opportunity to those who are willing and fit to share the labor and participate in the benefits; that unemployment should, next to death or disability, become the greatest of human dreads.

May selfishness, ambition and fanaticism be overcome and the universal brotherhood of man be fostered by the growing will for Peace, of which He was the Great Apostle.

F. R. Low

Editor Emeritus

Merry Christmas

Mr. Low again extends this Christmas greeting, first written in 1929, to the readers of POWER

50 CENTS OF EVERY POWER DOLLAR

WHY pay a dollar for a fifty-cent lunch? American industry spends one dollar for every fifty cents' worth of power services. This fifty per cent refers only to the waste in generation, transmission and application within the industrial establishment. It takes no account of any possible reduction in the rate schedule for purchased electricity or steam.

The figure given is not exact—merely an estimate. No adequate national industrial power survey has ever been made. It may never be, because of the cost. Yet, any industrialist can find plenty of specific cases of plants that have modernized operation, equipment and hook-up and that have published actual "before and after" figures, fully justifying this fifty-cent waste estimate for American industries as a whole. More of this later.

Industry cannot blame the government or any other outside agency for this waste of half its power dollars. It cannot even blame the depression; the condition existed before 1929. In those gaudy days many said that they were "not interested in saving"; most everybody acted that way. Today these same men "cannot afford" to save, or simply deny the existence of serious waste, even in the face of direct evidence to the contrary.

Where Is Management?

This situation reflects directly on management—top management. Executives may plead ignorance of power technicalities. They may say that they have been busy with more important matters. Yet how can they challenge that best definition of an executive, as a "man who makes those things happen that ought to happen, and keeps from happening those things that ought not to happen?" Never mind how, or by whom, it is his job to get things *done*—and done *right*.

Beyond question, a large proportion of America's leading industrial executives have simply fallen down on their jobs as far as the power services are concerned. Exhibits A to Z, proving this statement, are plastered over every state in the Union.

It is a rare plant that cannot cut power-service production costs twenty per cent. The average, as has been pointed out, is near fifty per cent, when one includes also transmission and application wastes, as well as those of generation.

Power costs run from four to ten per cent, or more, of the total manufacturing cost, according to the industry. It follows that manufacturing costs can be cut from one to five per cent by merely recognizing the existence of these losses, and by giving a competent engineer authority to eliminate them. Under existing conditions, the savings obtained will, in many cases, exceed the entire present net profit of the business. If the business is hovering on the red side of the profit line, it may well pull it into the black. If this is not a matter for executive consideration, what is?

The Power Engineer's Job

In this whole picture the relation of the top executive to his power engineer is of primary importance. First, he must recognize that the power engineer is a department head, responsible for manufacturing and *delivering* the various power services to factory departments. Like the head of any other factory department, the power engineer is responsible for the quality and uniformity of his products and for having them available when and where needed.

And finally, don't forget that he is responsible for power-service costs. This does not mean total monthly costs, but *unit* costs: cents per kilowatt-hour, cents per thousand pounds of steam, cents per thousand cubic feet of compressed air, etc.

As a measure of individual merit, the total monthly cost is almost meaningless, since it involves not only the skill of the engineer in producing and delivering the power services, but also the quantities used, which in turn are governed by factory activity and by the skill of production heads.

Therefore, hold the power engineer responsible for the *unit* costs of his power services. Require him to include capital and other fixed charges on his equipment to make these costs true. Finally give him authority to make profitable power-equipment investments. He will then make such investments only when they will decrease operating costs more than raise fixed charges. If you give him this responsibility—and this power that must logically go with it—you will completely align his selfish interests with your own. You will automatically put his ability to work for you and your stockholders—if he has ability.

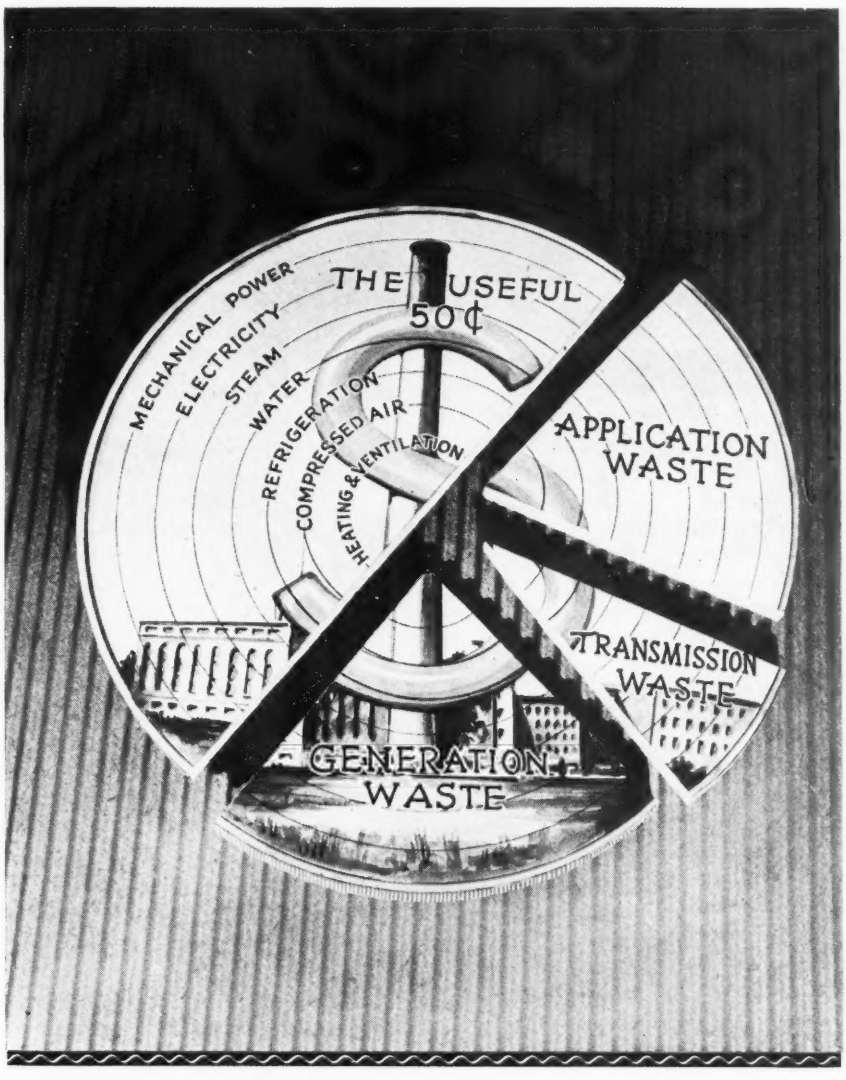
But be sure he *has* ability, both practical and analytical, for the power plant in clumsy hands is a dollar eater. No factory department reacts more quickly to intelligent handling. In none can the dollar effect of changes be more precisely figured in advance.

Why is it that industrial executives so frequently veto the plans of their power engineers? Is this not sure proof of bad management? If the recommendations are sound they should be followed. If they are persistently unsound, what is one to think of management which keeps an incompetent man in charge of a major department?

If one carries to the limit this conception of a power

IS WASTED!

This article, and ten more that follow it, are addressed to those top industrial executives who are not power experts. In the interest of more effective cooperation, Power *urges its readers to bring this section to the attention of company executives.*



Read Also:

2. WHAT IS A POWER PLANT? Page 670
3. WHEN TO BUY POWER Page 672
4. HOW TO BUY POWER Page 673
5. HOW TO REDUCE THE FUEL BILL Page 674
6. "FREE" POWER FROM PROCESS STEAM Page 676
7. IS THE DIESEL MORE ECONOMICAL? Page 678
8. HEATING, VENTILATING AND AIR-CONDITIONING Page 679
9. REFRIGERATION, WATER SERVICES Page 680
10. WHO PAYS THE FREIGHT ON POWER SERVICES? Page 681
11. SAVING POWER DOLLARS —A SUMMARY Page 682

engineer, with full responsibility for the unit costs of his power services, and full control of the operating and investment elements of those costs, he may conclude that this group of executive articles should stop right here. What more is there for the executive to know or do about his power problem?

The answer is that executives, being human, will not be able to keep their fingers out of the technical fires. They must therefore be shown where they are most likely to get their fingers burned.

Moreover, the best of engineers looks for intelligent judgment of his accomplishments and for appreciation of the major wastes he is combating. He requires protection against those countless executive power delusions and superstitions that so often wreck his best-laid plans for dollar saving. Hence these articles.

With a moratorium on the technical "B.t.u." jargon of the engineer, and without going further into detail than is worth while, the succeeding articles will take up in order the ten subjects listed on this page.

WHAT IS A POWER PLANT? — few executives know

THE general industrial executive does not need a detailed knowledge of power equipment. On the other hand, his failure to grasp the *general* picture of the power services is costing American industry hundreds of millions of dollars yearly in preventable waste. Any engineer who has studied the problem can certify that this statement is no exaggeration.

For this reason, all industrial executives are urged to study particularly the present article. In a single page of text, plus a single chart, it presents a skeleton of every conceivable type of industrial power plant, however complex.

First, it is necessary to forget entirely the ordinary conception of the "power plant" as a separate building in which are housed boilers, engines, etc. This definition is entirely inadequate, except in the case of a utility central station, which constitutes a single unit for the generation of electricity.

The following description applies entirely to industrial plants (including buildings and institutions):

What Is the Power Plant?

The power plant is all the equipment used to generate and transmit the power services. The power services are all the fluid services that flow through wires, pipes, ducts, shafts, belts, gears, etc. The power plant, then, lies not only in the power house but all over the factory.

The important power services are listed in the accompanying table. These may be produced from a variety of energy sources, and with a variety of equipment. For example, low-pressure steam for heating and process work may be produced by a boiler fired by coal, oil or gas. It may be produced by passing high-pressure steam through a reducing valve. Or the high-pressure steam may be carried to steam engines or turbines whose exhaust furnishes the low-pressure steam. Finally, additional low-pressure steam may be purchased or may be obtained from the waste-heat boiler of an oil or gas engine.

A clear picture of the possible sequences is obtainable from the master chart. This chart, showing practically all possible combinations, applies to any type of industrial power plant.

For analysis, the master chart divides the power plant into a group of elementary sub-power plants: Boiler plant, engine plant, diesel plant, etc. These sub-plants may be in separate parts of the establishment (for example, a separate compressor house), or they may be under a single roof.

Each of these sub-plants delivers one or more power services to the arteries at the right of the chart, wherein are pooled the various services from all sources of supply, including purchase.

This pooling is not merely physical, but has an accounting significance. Of the total quantity of each service produced, part flows to factory applications and part circles back through the arteries on the left to still other sub-plants.

For example, a boiler (sub-plant 1) may generate high-pressure steam from oil fuel. Part of this steam may circle out into the factory. Another part may go to a steam turbine (sub-plant 2), producing electricity and also exhaust steam. The electricity generated may be pooled with purchased electricity and used in part to supply factory departments, and in part to supply motor-driven pumps (sub-plant 5) and refrigerating equipment (sub-plant 8). These sub-plants in turn may supply water and refrigeration to an air-conditioning plant (sub-plant 9).

The combinations are endless, and so also are the possible cost systems. Yet any combination and any cost system may be represented by selected portions of this master chart.

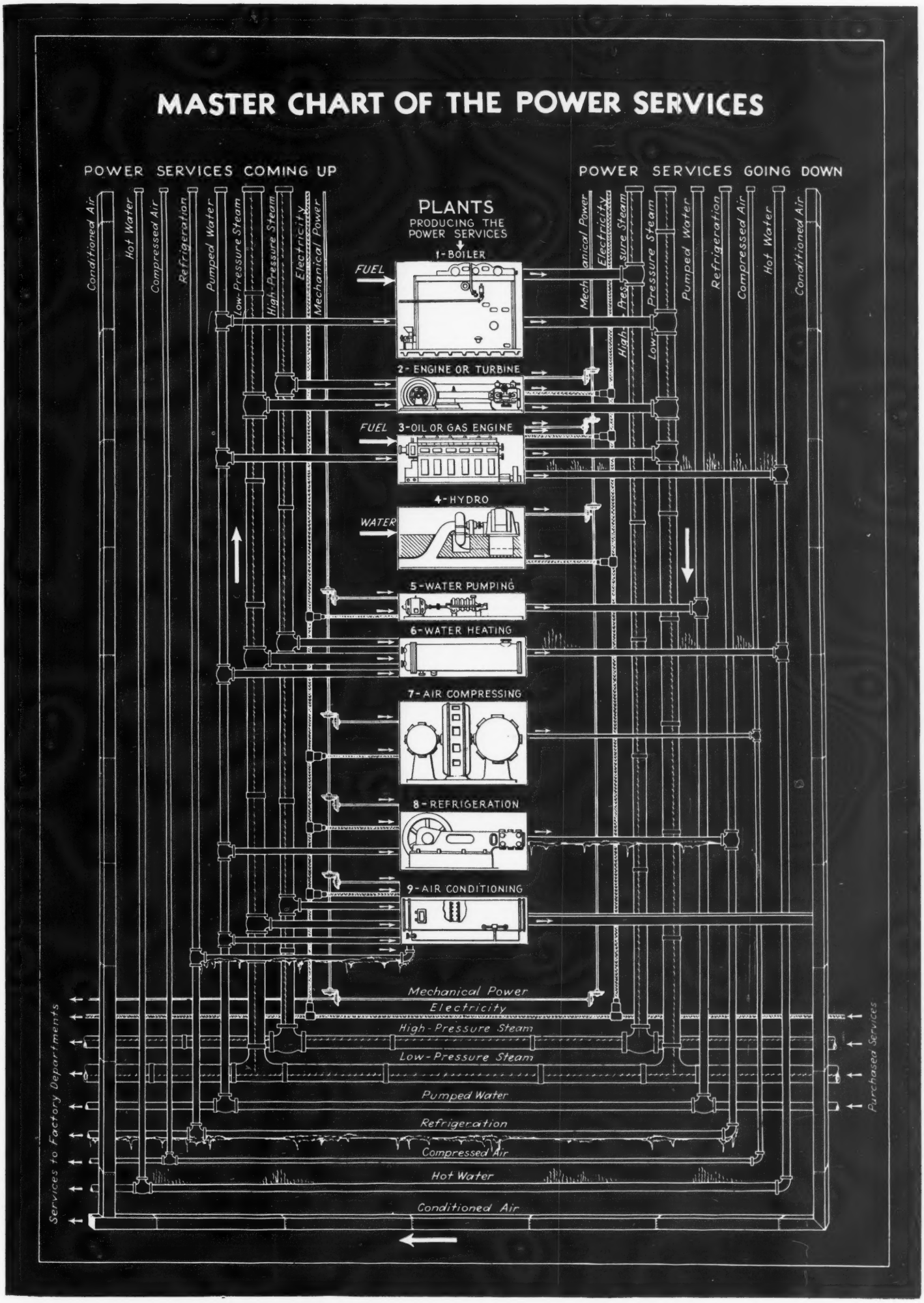
It is a good executive principle to have the engineer compute all unit costs for each power service. Accountants without engineering training are, in general, unable to grasp the meaning of the recirculation of the power services within the power plant. The only general accounting check needed is that the combined cost of all power services, as reported by the engineer, must equal the sum of all power-plant charges made by the accounting department. It is then well to permit the power plant to sell these services on a unit basis to the manufacturing department.

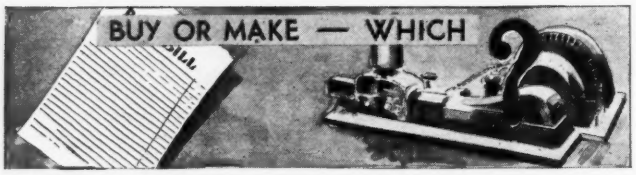
The present article lists the power services and breaks down the power plant into a group of sub-plants. This conception is the most important for the top executive to grasp. However, he may well go one step further and break down each sub-plant into its major equipment items and their basic relations. This will be done in a broad way by the subsequent articles of this executive group.

The Power Services

Mechanical Power	**Pumped Water**
Electricity	**Refrigeration**
High-pressure Steam	**Compressed Air**
Low-pressure Steam	**Hot Water**
Conditioned Air	

MASTER CHART OF THE POWER SERVICES





WHEN TO BUY POWER

ENGINEERS who have made an impartial study of hundreds of industrial plants are amazed at the frequent utter disregard of elementary economics in the decision to purchase power or make it locally. Among the many thousands of industrial plants that mishandle this end of their power problem are many which bear every outward mark of good management.

Countless factories that should buy power make their own. Countless others that could profit handsomely by local generation insist on buying all power. The cause, more often than not, is the mental "set" of some high executive for or against purchased power.

Here are two samples: Textile executive *A* buys all his power, running a boiler plant for process and heating steam only. He "eats, dreams and sleeps" textiles. Power is his blind spot.

His engineer suggests local power generation as a partial by-product of his heating and process steam. Executive *A* is disinterested, skeptical. "We are specialists in textiles. We buy textile machinery from specialists in that field. Doesn't it pay to buy power also from specialists? Doesn't it stand to reason that a large power plant can make and sell power more cheaply than we could make it in a small factory plant?" When the engineer presents figures showing that local power generation would actually be cheaper for this particular factory, Executive *A* dismisses him impatiently on the ground that his conclusions are contrary to common sense.

Now for an example of the reverse situation. Industrial executive *B* has a plant with antique engine-driven generators. The savings possible with a new make of engine are brought to his attention through friendship or good salesmanship. He installs the new engines to make these savings, but forgets or refuses first to see whether purchased power might be still cheaper.

No textile plant could manufacture a modern motor truck cheaper than it could buy it. The non-power-trained executive therefore naturally asks how locally generated power can ever be cheaper than that furnished by a company whose entire skill and time are devoted to the production of power alone.

The answer involves several factors. The first is that utility transmission and distribution costs are generally much larger than the cost of generation. The sales price of energy must include these, and also profit. The second point is that the generating cost to the industrial, which is its delivered cost, may, under very favorable circumstances, be even lower than the mere *generating* cost to the utility.

A business man may well be incredulous at the statement that a 1,000-kw. industrial plant may generate power more cheaply than a 100,000-kw. central station of the latest design, expertly operated. Yet this possibility is recognized by all engineers, and there are many hundreds of checkable examples in the United States. The explanation is almost always found in the production of power as a "by-product" of process and heating steam. The power is produced much as sawdust and shavings are produced in a furniture factory.

All industrial plants outside of the tropics require some steam for building heating. In addition, many industries require great quantities of steam for process work. This is particularly true in such industries as chemicals, soap, meat packing, canning, dyeing, pulp and paper, oil refining and rubber manufacture.

Boilers for producing this steam must be operated in any case, whether power is purchased or generated locally. By generating the steam at a higher pressure than the processes require, and passing it first through engines or turbines that exhaust to process, the power is practically a by-product. Under these ideal conditions the additional coal chargeable to power generation will be less than one-half pound per kilowatt-hour, whereas the very best central station will use about one pound.

Of course, by-product power carries an investment charge, as well as a coal charge, but here again, since the boilers are needed in any case, the power-producing investment is confined mainly to engines or turbines with their generators.

The ability to generate all power as a by-product of process heating steam is the most favorable condition for local power production. It is also an exceptonal condition. Because of falling off of steam load in summer, and at other times when large blocks of power may be demanded, the average industrial finds that it can generate only part of its power as a by-product. It thus generates certain blocks of power at a very low cost, and certain other blocks at a cost which may considerably exceed that of purchased power. The saving on one block may or may not counterbalance the loss on the other. It may or may not be commercially feasible to generate the cheap block locally and buy the other.

The actual working out of this problem for any specific industrial is a complex engineering problem, requiring the best effort of the plant's power engineer. It is generally well also to pay the cost of an adequate survey by an independent consulting engineer who will make a detailed study of hour-by-hour steam and power load variations for the various seasons, and make also a detailed analysis of the utility rate schedule.

The generation of power as a by-product of process and heating steam is further discussed in the article on page 676.

HOW TO BUY IT

THE problem of purchased power versus local generation has been treated in the technical press for many years, and intensively so for at least ten years. Less attention has been paid to the art of buying power. Here, then, is a great field for saving.

Rate schedules for purchased electricity are almost always complex documents, including "energy charges" on a sliding scale, "maximum-demand" charges, penalties or bonuses for low or high "power factor," and sometimes a "coal adjustment" clause. The situation may be further complicated by the existence of several different rate schedules for different types of consumers.

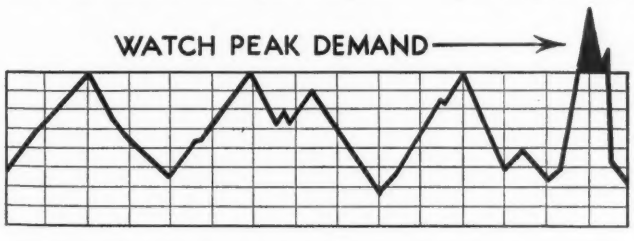
Three considerations, then, become of great importance in the purchase of power: 1. The buyer must know for a certainty his legal freedom of choice in selecting the schedule under which he will operate. 2. He must be able to analyze each of these schedules in terms of his present and expected power load to see which schedule will give the lowest over-all cost. 3. He must know how to operate his power-using equipment in such a way as to avoid certain dollar penalties that are implicit in almost every power schedule.

In the practice of this relatively new art of buying power economically, most industrial executives could learn much of value by studying the carefully worked out procedure of the National Biscuit Co., which operates 85 factories in the United States and Canada. Some of these generate power; some buy all their power.

The central engineering department of this company checks and approves all power bills. At intervals a representative of the engineering department visits the public-service commissions in the capitals of the states in which the various plants are located. He consults the files there to see whether the company is being billed at the best available rates. In addition, the home office maintains a file of available rates.

The commercial significance of this work, together with the constant check-up of power and steam generating costs, and of all power-service costs, is evidenced in a net yearly saving of over $500,000 made by the National Biscuit Company in its power-service cost.

In the majority of cases the industrial can get expert help from the utilitiy itself in selection of the proper rate schedule, and in operating with the greatest economy under that schedule. At times, however, it may be discovered that a comparable plant is operating under a more favorable schedule. The industrial may then properly demand the right to enjoy the same schedule, and may, if necessary, carry the case to the state utility commission.



For the purpose of the non-technical executive the complexities of rate schedules may be reduced to a few simple principles. First is the established general business principle that the man who buys more pays less per unit purchased. This is ordinarily taken care of by a sliding scale for kilowatt-hours.

Added to this "energy charge" is a special charge for the utility's "readiness to serve." It is obvious that the utility incurs an investment expense by merely standing ready to supply a certain amount of power, even if the customer rarely draws upon this supply. This expense is commonly taken care of by the so-called "demand charge," based on the heaviest load during a month or year. The demand period ranges in different schedules from five to thirty minutes. Proof of the demand is supplied by the records of the recording demand meter.

Sometimes both executive and power engineer overlook the tremendously important fact that a 10-min. peak load on the thirtieth of the month, while consuming a trivial amount of energy, may greatly increase the demand cost for the whole month, incurring a penalty amounting to hundreds of dollars. This situation may be avoided by cutting out, at such times, certain non-essential loads, such as air compressors or ventilation, or by staggering the starting of factory departments.

Almost instantaneous action is required to avoid the penalty. An automatically-sounded alarm, however, may give the engineer time to pull certain switches before the five or ten-minute period is up. Greater protection is provided by demand-limiting devices which automatically switch off certain non-essential motors or other loads when the demand is about to be pushed to a new high.

Finally many rate schedules include a penalty for low "power factor." The reason for this is that the capacity of transmission lines and distribution lines, transformers and generators, varies directly as the power factor. If the power factor is 100 per cent, a 1,000-kw. generator can supply a 1,000-kw. load. The same generator can supply only 750-kw. if the load has a power factor of 75 per cent. This applies also to transformers and power lines.

Hence, from the utility point of view, low power factor means low use of investment, or, conversely, high investment for a given kilowatt output. It is, therefore, common practice to penalize low power factor.

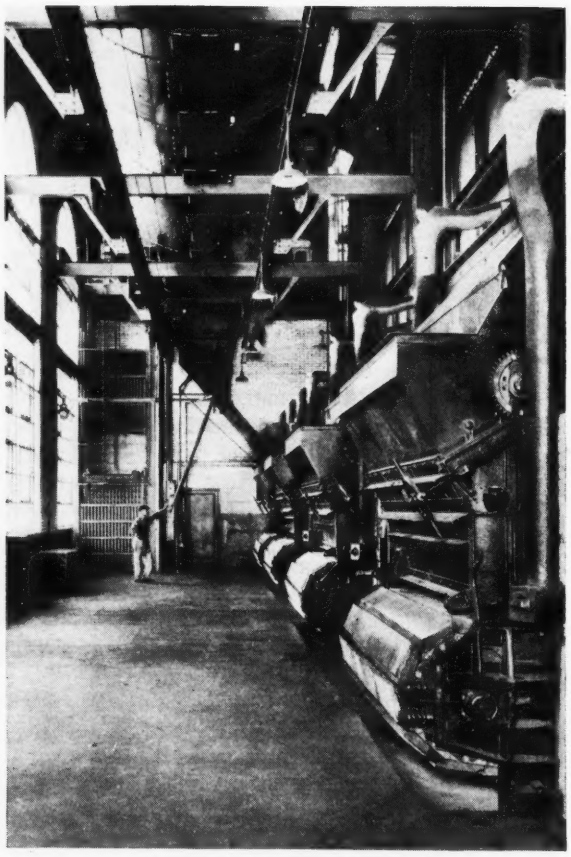
The details of any power-factor improvement campaign are necessarily matters for engineering decision. The general executive, however, must be aware of the fact that there is a power-factor problem and that it definitely affects his manufacturing cost.

HOW

TO REDUCE THE

FUEL BILL

1. SELECT FUEL WISELY
2. BUY IT SHREWDLY
3. FIRE MECHANICALLY
4. BURN EFFICIENTLY
5. CUT HEAT WASTES



ABOLISH THE SHOVEL

"ACTS OF GOD" may well represent the typical executive conception of fuel bills. Yet it is not at all unusual to see these bills cut almost in half. Measures necessary to reach this much-desired end fall into three groups: 1, Better fuel buying; 2, Eliminating boiler-room wastes; 3, Reduction of steam demand.

Reducing the steam demand involves the method of obtaining or generating power (see articles on pages 673 and 676), the effectiveness of the distribution system (page 681), intelligent application.

The present article will concentrate entirely on those dollar wastes that fall under headings 1 and 2. It is safe to say that, even without reducing steam consumption, the average industrial plant that has not been expertly engineered can reduce its fuel bill at least 25 per cent.

Since the cost of coal varies widely in different parts of the country, the coal cost of steam may vary from 10 to 40 cents per 1,000 lb., so that this cannot serve as fair basis for comparing plants in different sections. There is, however, one national and natural basis on which one boiler room may be compared with another. That is over-all efficiency, the fraction of the heat in the coal delivered to the steam produced. An efficiency of 60 per cent is bad, and 50 per cent is something to blush about. There is no excuse for any modern boiler room operating at less than 70 per cent efficiency, unless coal is available at some such gift price as 50 cents a ton.

Three primary factors determine boiler-room efficiency: 1. Kind of coal; 2. Kind and condition of equipment; 3. Skill of operation. These will be taken up in order.

Buying Coal

Buying coal would appear to be a simple commercial operation. Actually, the process is hedged with difficulties. The buyer faces a great variety of coals: hard and soft, high-ash and low-ash, with high and low ash-fusion temperature, high and low volatile content, high and low heat value, and a wide range of sizes.

The first step toward scientific coal buying was recognition of the relative heat values of the various coals. One coal may develop 11,000 heat units per lb., another 14,000. Other things being equal, their relative values should be in this proportion. Unfortunately, other things are not equal. For example, coal with a high proportion of easily melted ash tends to form clinker, and is therefore difficult to burn in certain types of furnaces. This kind of coal has generally a low heat value.

Consumer demand in some regions tends to concentrate on coals of high heat value, having also low ash and high melting temperature of the ash. This demand forces up the price of such coals to a point where they command a premium out of proportion to their margin of heat value. In such a market, the industrial plant with adaptable firing equipment may often save money by shrewdly selecting so-called "poor" coals.

This matter of coal selection is a long story, and the reader interested in further advice is referred to G. B. Gould's articles on coal buying in *Power* for May, June and December, 1933.

When new fuel-burning equipment is installed, it is extremely important to consider not only the fuel now in use, but all possible fuels that may be (or become) available in the region. The stoker or pulverizer and boiler furnace that are designed to handle almost any kind of coal give the fuel buyer a free hand to seek out the "B.t.u. bargains" of the moment—those coals that supply the greatest number of heat units per dollar expended. It frequently happens that coal-buying flexibility will permit a net saving of 50 cents or

more per ton, after allowances are made for relative heat values. Where oil or natural gas are available fuels, the possibility of their use should be carefully considered. It may pay to install furnaces that can easily be converted from solid to fluid fuel.

Boiler-Room Equipment

The kind and condition of boiler-room equipment has an enormous effect on efficiency, labor costs and steam costs. The typical high-steam-cost boiler room houses a large number of small, low-set, hand-fired boilers, operated hit or miss with natural draft and without waste-heat recovery of any sort. "Operation" consists in carting coal up and ash away in wheelbarrows, setting dampers and shoveling to keep up steam pressure, hand regulating the feed water, cleaning the boilers occasionally when soot and scale become intolerable.

At the other extreme is the most modern industrial boiler room. Boilers are fewer and much larger, particularly higher. Each produces as much steam as several small boilers. Where solid fuel is used, these modern boilers are fired automatically by mechanical stokers or by coal pulverizers. Mechanical-draft fans are used and automatically controlled to maintain constant steam pressure. Feed-water supply is automatically controlled by water level. Automatic control may even be applied to regulate the speed of stokers and fans, and the setting of draft dampers. Instruments give a continuous record of steam and combustion conditions.

Devices are installed to recover waste heat from stack gases. These may be "economizers" to heat the feed water, or air heaters to preheat the combustion air.

This modern boiler room also uses exhaust steam in "open" feed-water heaters to raise feed-water temperature to 212 deg. F. before it goes to the boilers. Finally, this boiler room is provided with automatic coal-handling equipment and with chemical or other devices to soften feed water and thus eliminate the nuisance and heat waste caused by scale formation in boilers. Permanently installed soot blowers provide for clean tubes on the fire side.

In painting this picture of the ultra-modern boiler room, there is no intention of implying that the best-planned boiler room will contain all of the equipment mentioned. For example, it may not pay to install both "economizers" and air heaters. Sometimes both may be properly omitted.

The outstanding boiler-room loss, often amounting to 20 per cent of the entire coal bill, may be described as that of using the boiler as a "hot-air furnace to heat up the sky." For every ton of coal burned, from 12 to 25 tons of gases at 500 or 600 deg. F. pass up the stack. Reduction of this waste is first a matter of reducing the amount of excess air supplied and, secondly, of reducing the temperature of the gases going up the stack. The first step is the more important.

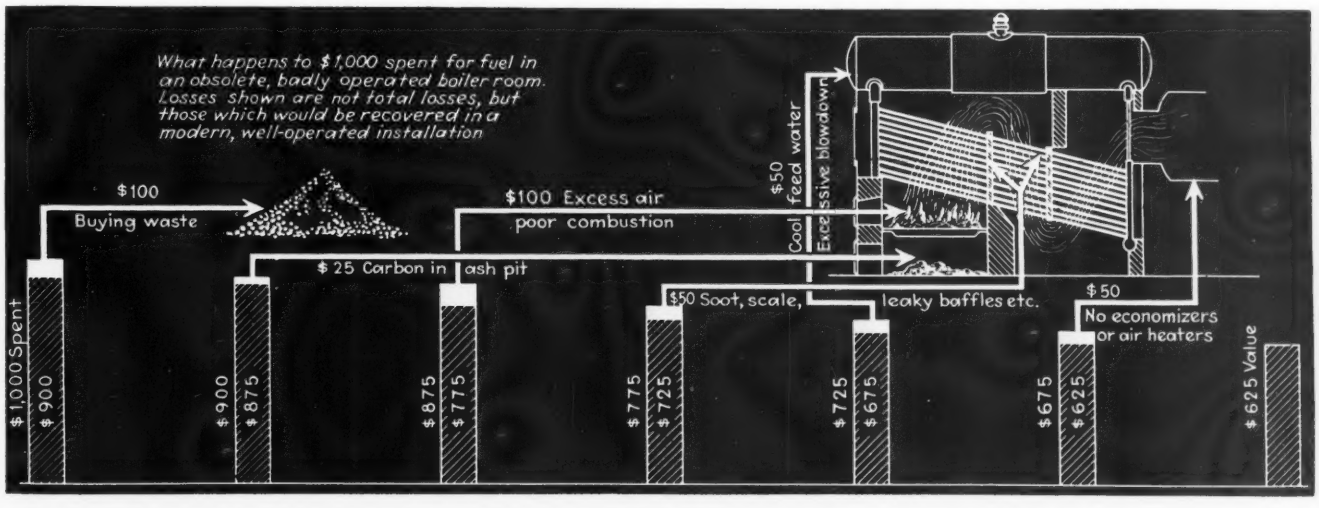
Every boiler should be provided with instruments for measuring excess air. Their value may easily be represented by a yearly saving of 10 per cent of the entire fuel bill. In addition, it will often pay to install automatic combustion control equipment to insure better maintenance of the exact combustion conditions than is normally practicable with hand control.

Further substantial savings may be made by reducing the temperature of the chimney gases by keeping the baffles tight, by keeping the boiler tubes clean of soot on the outside and scale on the inside, and by installing "economizers" or air heaters.

The place to attack high excess air is not in the stack, but in the firing equipment and furnace. Stokers or pulverized fuel equipment must be so arranged that air admitted comes easily into contact with the whole mass of fuel. Stratification or concentration of air in one spot will result in unnecessary excess air. Too small a furnace will make it impossible to burn efficiently enough coal for high load. It may also lead to smoke. Contrary to the old superstition, it is better to have the boiler far above the fire rather than close to it.

For high efficiency it is generally well to have some boiler walls cooled by air or by water tubes. The reason is this: High efficiency demands low excess air, but this invariably means a very hot furnace, which may melt down solid refractory walls. To prevent this waste, the operator increases the amount of excess air, with consequent damage to the coal bill. Air or water-cooling of the walls eliminates this necessity.

The diagram indicates in a rough way what happens to the money spent for coal. Preventable losses vary widely from plant to plant, but those indicated are representative of what might happen in changing from a badly operated antiquated plant to a well-operated modern plant. In the case indicated, $1,000 worth of coal delivers steam that would require only $625 worth of coal with the most up-to-date fuel buying, boiler-room equipment and operation.



"FREE POWER" FROM PROCESS

THE strangest paradox of industrial power generation is wrapped up in the phrase, "by-product power," already mentioned briefly in the article, "When to Buy Power," on page 672. The basic idea is that steam can do two jobs—heating and power generating—for much less than the sum of the costs of doing each separately. In fact, under certain favorable conditions, the amount of steam required for heating plus power generation is very little more than would be required for heating alone. "Heating" here refers to any application of steam for the sake of its heat, whether it be to radiators, dye vats, kettles, paper machines or for other uses.

Skim Milk and Cream

The process is analogous to the skimming of cream from whole milk. Suppose a dairy has certain products for which whole milk and skim milk are equally suitable. Suppose, also, it has a market for cream. It is then sound procedure to skim all milk before turning it into the manufacture of those products, and to sell the cream as a by-product.

The analogy is close. Only a fraction of the heat in high-pressure steam ("whole milk") can be turned into power ("cream"). This fraction ranges from 8 to 30 per cent. The remaining 92 to 70 per cent, in the form of low-pressure exhaust steam, is now "skim milk," no longer of any value for power generation, but just as good as high-pressure steam for heating and process use.

In the case of central-station power generation, this heat is thrown into the river for lack of a local market. The utility, then, is in the position of a cream manufacturer with no outlet for skim milk. Here the industrial plant has a definite advantage, because it can use the residue.

In plain English, "by-product power" generation means that electricity is generated by turbines or engines which deliver their exhaust steam to manufacturing processes and building heating systems. Boiler steam may come to the engine throttle at 100 lb. pressure, 200 lb., 300 lb., or more. It may exhaust at any lower pressure, but a large proportion of process and heating operations can be properly handled at 5 lb. pressure or less, with but few really requiring pressures as high as 50 or 100 lb.

If much power is needed in proportion to the process steam required, it often pays to run up the boiler pressure and to carry the process and heating pressure as low as possible. This increases the range available for the expansion of steam and the resulting quantity of power which may be "skimmed."

If too small an expansion range is available, the flow of process and heating steam through the engine may not be sufficient to generate the required amount of power. To generate additional power needed, additional steam must pass through the engine to the atmospheric exhaust—a very serious waste of fuel.

In its fuel cost, the cheapest of all forms of steam power is by-product power, which requires less than ½ lb. of coal per kw.-hr. Second comes power generated by large condensing central stations, plants in which steam exhausts from the turbines into condensers at high vacuum. Generation of power in this manner requires from 1 to 2 lb. of coal per kw.-hr., with a national average around 1½ lb.

A very bad third is the power generated in industrial plants by steam engines or turbines exhausting entirely to atmosphere. These require from 3 to 6 lb. of coal per kw.-hr.

The whole secret of generating industrial steam power at low fuel cost is to produce as much as possible as a by-product of heating and process steam, thus reducing to a minimum the amount which must be generated by steam exhausted to a condenser or to atmosphere.

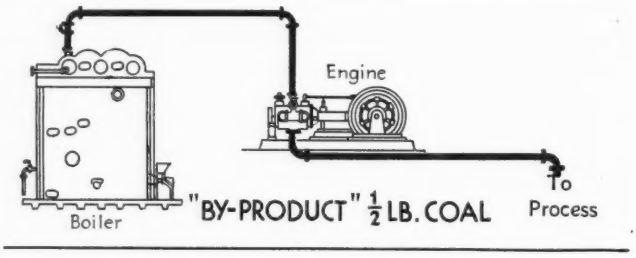
The ability to generate by-product power depends upon the existence of a substantial steam heating and process load. In all Northern plants building heating is a large item in the winter. In addition, many industries—notably soap, pulp and paper, rubber, chemicals, oil refining, bleaching, and dyeing, tanning, packing—require large quantities of process steam. It is in such industries that the greatest opportunity exists to produce power more cheaply than it can be purchased.

Because the demand for heating steam varies with season, summer power in industrial plants often costs much more than winter power. It is therefore sometimes advantageous, where the utility rates are adaptable, to draw upon a utility connection for much of the power used during the summer months.

Detailed engineering cost analyses are the only safe basis for a decision to purchase power or to generate it locally. A brief outline of the steps will indicate the complexity of the problem and make clear why executive snap decisions in this field are so often wrong.

Estimating Power Cost

Granted equal reliability and quality of service, power should be obtained from the cheapest source. At the very start one encounters the problem of defining power cost. Here the fact that steam for heat and process must be generated locally in any case gives a place to start from. Deduct from the combined cost of power and heating steam the cost of producing heating steam alone in a plant operated solely for that service. The dif-



ference will be the cost of power. This will hold true whether all the power is purchased, whether it is all generated locally or whether it is partly purchased and partly generated.

The first step, then, in the analysis of a specific factory is to figure the cost of generating heating steam alone. The second step is to consider the various plausible methods of obtaining power and to figure for each the combined cost of power and heating steam. The method which gives the lowest combined cost should be selected.

Estimation of this combined cost is an arduous task. It is necessary first to arrive at the approximate design of a plant for each proposed method and to determine the characteristics and cost of each such plant. Here consideration must be given to steam engines and turbines, diesel engines, various boiler pressures, etc., etc.

The characteristics of each plant are then applied to the hour-by-hour power and heating steam loads of the factory for the various seasons. A similar application must be made of the rate schedule for purchased power. Ultimately, the analyst arrives at the total cost of obtaining power by each proposed method.

This bare outline of the procedure clearly proves the need of the very best engineering advice in deciding when and how to generate power. It is a job for a consulting engineer of the first rank, a man intimately familiar with power problems and with the practices of the given industry. Finally the consulting engineer selected should be one whose record reveals no bias for or against purchased power.

High-Pressure Steam

As already indicated, the steam pressure has a very great influence on the amount of power that can be generated as a by-product of a given amount of process steam. If the exhaust steam exceeds the heating and process demand of the plant, the excess of supply over demand must be wasted to atmosphere. With higher steam pressure the engine will require much less steam and the waste will be correspondingly reduced. With high enough steam pressure, free exhaust may be entirely eliminated and much fuel saved.

Recognition of this opportunity for large savings accounts for the rapid rise of steam pressures in certain industries that are notable users of power and steam. A good example is the paper industry, where steam pressures ranging from 400 to 600 lb. have become almost standard. In spite of certain fears in the early days, operation in this pressure range involve no particular difficulties or danger.

Generation of steam at higher pressure does not, in and of itself, increase the coal consumption. The slight increase in the amount of coal required to produce *one pound* of high-pressure steam is exactly balanced by the slightly greater amount of heat in each pound of high-pressure steam.

Where the demand for process steam exceeds the requirements of the engines or turbines, the excess is passed through reducing valves, which deliver it at the constant correct low pressure to the process or heating system.

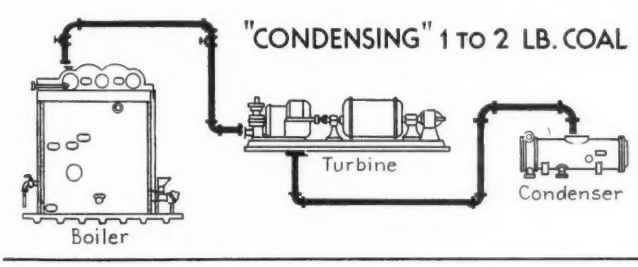
Choice between the steam engine and the turbine involves many practical and technical considerations. In small sizes, steam engines of the uniflow type are more efficient than turbines. Turbines, on the other hand, are smaller and cheaper, because of their higher speed. Efficiency is of importance only where the inefficient prime mover is unable to generate all of the power demand as a by-product. For the higher pressures, turbines are more commonly used, although engines can be built for any pressure.

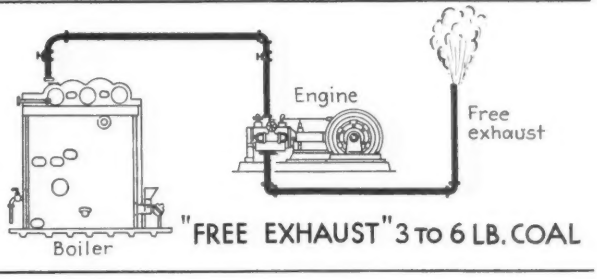
For industrial use, the straight condensing turbine, which passes all exhaust to a condenser under vacuum, should generally be avoided, for reasons already mentioned, although it is the type almost invariably used in central-station service.

What Kind of Operation?

Two common types remain to be considered—the "straight back-pressure" turbine and the "bleeder" turbine. The former is a simple by-product power unit in which steam entering at the throttle passes right through the machine and exhausts to process. This type should be used wherever it will generate ample power with a reasonable steam pressure. Where more power is needed than can be generated as a straight by-product, the bleeder turbine is ordinarily used. This is a condensing unit (generally), with a tap on the side from which steam at moderate pressure can be drawn off or "bled" for process or heating use. The steam so drawn off generates true by-product power, the kind that consumes ½ lb. of coal per kw.-hr. Additional power is generated at considerably higher cost by the steam that remains in the turbine after the bleed point, and passes finally to waste in the condenser.

It is not expected that the non-technical executive will attempt to carry even this bare outline in his head. This article will have served its purpose if it reduces in some degree the many millions of dollars wasted yearly by executives who persist in making power decisions without adequate and unbiased engineering surveys.





IS THE DIESEL ENGINE MORE ECONOMICAL?

IS DIESEL power cheaper than steam power? The question has no general answer. Yet, as a machine for converting heat energy into mechanical or electrical energy, the diesel surpasses any steam plant *devoted to the production of power alone.* At good load it will convert 30 to 35 per cent of the fuel heat into electrical energy, whereas the most modern large steam central station converts 28 per cent. Moreover, a small diesel engine gives an efficiency comparable with that of a large engine, whereas the efficiency of the steam power plant falls off considerably as the size get smaller, thus greatly increasing the diesel's margin of efficiency.

Right here we should show briefly how a diesel engine works by comparing its operation with that of an ordinary gasoline engine. The gasoline engine sucks in a mixture of air and gasoline vapor. On the up-stroke it compresses this mixture to about 150 lb. per sq.in. pressure. At the top of the stroke, approximately, the mixture is ignited by the spark. The resulting "explosion" drives the piston down. As it comes back up, the piston expels the burned gases, thus completing the cycle. The diesel cycle of operation bears some general resemblance to this, but the details of its operation are quite different.

It is a fundamental principle of all expanding-gas engines, that greater compression produces greater efficiency. However, compression heats the gases. Since the ordinary gasoline engine compresses a combustible mixture of vapor and air, the compression pressure is limited to values below 150 lb. per sq.in., because higher compression would heat the mixtures above the ignition point and thus anticipate the action of the spark.

The diesel engine avoids this difficulty by compressing a non-combustible gas—pure air. No pre-ignition is possible, because there is no fuel in the cylinder during the compression stroke. The compression is therefore limited only by mechanical considerations, such as the strength of engine parts. A typical compression pressure with a diesel engine is 500 lb. per sq.in. This alone accounts for the high efficiency obtained. Equal efficiency could be obtained in a gasoline engine if the same compression were practicable.

The high diesel compression also performs a function absolutely necessary to the operation of the engine, by raising the air to a temperature that will instantly ignite any oil, heavy or light, that may be introduced into the cylinder. No "carburetion" is necessary; the fuel oil is sprayed directly into the cylinder at the end of compression. Ignited by the heat of compression, it burns like a blow torch and heats the air in the cylinder to a much higher temperature. The hot high-pressure gases expand and produce power on the downward stroke. After finishing its downward working stroke, the piston returns to blow out the waste gases through the open exhaust valve.

Time does not permit further discussion of diesel-engine mechanics, so we shall turn at once to the question of operating cost.

Fuel costs are easy to estimate. At full load, a diesel engine will use about ½ lb. of fuel oil per kw.-hr. This is about one-half the consumption of gasoline by a high-class automobile engine operating at full load. In addition, diesel oil is much cheaper than gasoline, generally running from three to seven cents per gallon (0.4 cent to one cent per lb.). Thus, the fuel cost at best load may range from one-fifth cent to one-half cent per kilowatt-hour. At partial load, moreover, diesel efficiency holds up much better than does that of a gasoline engine. Another point to remember is that the jacket-water heat may be salvaged for process use. In addition, waste-heat boilers may recover about one-half of the exhaust heat. Credit for this heat may cut the fuel cost of diesel power practically in half.

It is evident that the relative cost of diesel and steam power will depend on many factors, and vary widely from place to place. For example, coal varies in cost from $2 to $8 a ton, depending on the kind of coal and the location of the plant. Fuel chargeable to power in a steam plant will range from one-half pound for a by-product power installation through 1¼ lb. for large central stations, to 4 or 5 lb. for industrial plants in which all exhaust steam is wasted to atmosphere. This gives an extreme range of fuel cost of steam power from one-twentieth of a cent to two cents per kilowatt-hour. Without considering variations in other operating costs of steam plants, or in their fixed charges, it is obvious that the steam power will sometimes be much cheaper than diesel power, and sometimes much more expensive.

Very frequently it will be cheaper to use two or three of these sources in unison. Thus, industrial plants may find it best to generate steam power in winter, but use diesel or purchased power in summer.

Along with the diesel engine, a sister prime mover, the gas engine, is now becoming of great importance in regions supplied with cheap natural gas. A good gas engine of fair size will consume about 15 cu.ft. of natural gas per kw.-hr. With natural gas at 20c. per thousand cubic feet, this gives a *fuel* cost of only 3 mills per kilowatt-hour. Here again labor, maintenance and fixed charges must be added to get the total cost.

BETTER HEATING VENTILATING AIR CONDITIONING at LOWER COST

AS POINTED out on page 670, the industrial power engineer is properly responsible for the generation, transmission and application of all the power services. These include steam, electricity, mechanical power, refrigeration, water, heating, ventilation and air conditioning. The last three will be discussed briefly here.

Heating still represents the biggest cost, and the most important of the three services, in the great majority of industrial plants. Executives often fail to realize that great savings in heating steam are obtainable without cutting the quality of service, or may even make actual improvements in that service.

Where simple radiators are fed with steam at a constant pressure of two or three pounds, and where these radiators deliver their condensed returns to ordinary traps, each radiator is either entirely on or completely off. The room, then, is generally too hot or too cold. If too hot, the windows are opened to waste the surplus heat.

The secret of economy is to supply to each radiator just enough heat to raise the room to the desired temperature, and no more, and in the majority of cases to keep this control out of the inefficient hands of the occupants.

Space will not permit describing the innumerable systems of direct radiation, but some may be mentioned briefly. Supply of steam to individual radiators may be controlled by room thermostats. Almost the same results can be obtained at lower investment cost by grouping various sections of the factory into zones, each with its separate supply line and control. The amount of steam fed to each zone may then be centrally controlled according to the nature of the zone, the outside temperature, the direction and velocity of the wind.

Orifices are frequently employed to assist in this control. In addition, hand or automatic control may be used, all under the direct supervision of the power engineer.

Uneven heating may be improved by shifting radiator sizes to balance inequalities. The temperatures of all radiators may be raised or lowered simultaneously by using a two-pipe system in which the return pipe is kept under vacuum by a special vacuum pump in the powerhouse. This system utilizes that property of steam which makes its temperature vary with the pressure. At atmospheric pressure steam has a temperature of 212 deg. F. At 5-lb. pressure the temperature is 227 deg. At 5-lb. vacuum it drops to 192 deg.

For large open spaces in factories, particularly in rooms with high ceilings, unit heaters combine economical operation with close temperature control. A unit heater is a simple box-like structure which may be attached to a column or other building framework. Within is a finned-tube radiator and a fan driven by electric motor or steam turbine. The fan circulates room air across the radiator into the room.

The unit heater has three advantages: 1. First cost is low, because a small amount of radiating surface delivers an immense amount of heat when subjected to air blast. 2. Varying the blast velocity gives effective control of the amount of heat delivered. 3. The forced circulation of the air makes for a more even temperature from floor to ceiling. Thus it becomes unnecessary to heat the ceiling to 80-deg. in order to maintain a temperature of 70 deg. at the working level.

Space does not permit saying much about ventilation, except to point out the fact that the design and application of fans, ducts, and tempering coils is a difficult engineering problem, calling for both theoretical and practical skill. The incorrect design and operation of such a system will result in poor service and high cost.

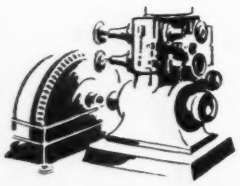
Air Conditioning

This is even more true of air conditioning. Completely conditioned air is air whose temperature, humidity and motion are under control at all times. Dust removal by filtering or washing is also assumed.

Humidification in winter is simply a matter of adding the necessary moisture by means of showers or sprays. The amount added is controlled automatically by a humidity-sensitive control in the outlet. Cooling is a more difficult problem. A certain amount of cooling can be accomplished by sprays of ordinary service water, but this may give too high humidity. Complete air conditioning generally requires mechanical refrigeration, both to cool the air in summer and to precipitate moisture when the humidity exceeds the desired level.

The necessary refrigeration may be produced by ammonia machines, by carbon-dioxide machines, and now, also, by the new steam-vacuum system of refrigeration. Steam jet refrigeration utilizes the principle that the boiling temperature of water, which is 212 deg. at atmospheric pressure, falls steadily as the absolute pressure is reduced. To put it another way, water under vacuum boils at a lower and lower temperature as the vacuum is increased. For example, at 99 per cent of a perfect vacuum, the boiling temperature is 45 deg. F. Several refrigerating systems operating on this principle have recently been placed on the market.

REFRIGERATION AND WATER COSTS ARE CONTROLLABLE



DEGREES MEAN DOLLARS IN REFRIGERATION

REFRIGERATION is a complex subject with many technical ramifications, but the basic idea is rather simple. Fundamentally, refrigeration is almost always produced by a boiling liquid. Even water boiling in the kettle on the kitchen stove is really a refrigerating outfit, because it cools the gas flame that strikes the kettle. But, since the water boils at 212 deg., it cannot cool anything below that temperature, unless the boiling temperature is reduced by reducing the pressure below that of the atmosphere.

Commercial refrigeration requires a variety of temperatures, but generally something in the range from 40 deg. below zero to 50 above. The problem is to find a liquid that boils at the right temperature under a comcially practicable pressure. With any liquid (including water), higher pressures give higher boiling temperature. Thus, by choosing among various liquids, and by regulating the pressure, any desired refrigerating temperature may be produced.

The most common type of refrigerating plant is that in which mechanical compressors, driven by engines or motors, are used to compress the vapor after the boiling operation, so that it can be liquified in a "condenser," Most of the substances used in refrigeration are gases or vapors at atmospheric pressure. These include ammonia, carbon dioxide, sulphur dioxide, methyl chloride and many others.

Consider an ammonia-compressor system of regrigeration. The piston con.presses the gas to about 145 lb. pressure. At this pressure the gas is cooled by water in condenser coils and is thereby condensed to liquid ammonia (not to be confused with a solution of ammonia in water). This operation is the reverse of boiling, and gives off heat to the cooling water.

The liquid ammonia then passes through an expansion valve, where its pressure is immediately lowered to the pressure on the suction side of the ammonia compressor. At this lower pressure, the liquid ammonia spontaneously boils and soaks up the necessary heat from any surrounding substance. Generally, the ammonia in pipes is used to cool non-freezing brine, which in turn is circulated to ice-freezing tanks, to cold-storage rooms or other applications.

The temperature of refrigeration is controlled by regulating the suction pressure of the compressor. With ammonia, for example, a suction pressure of 15 lb. gage gives an ammonia temperature of 0 deg., while a suction pressure of 30 lb. gage gives 17 deg. above zero. Other refrigerants, such as sulphur dioxide and carbon dioxide, require entirely different suction or boiling pressures to produce the same temperatures. Selection of a refrigerant depends upon the particular service.

Refrigeration is essentially a process of pumping heat in a direction opposite to its natural flow; that is, from the colder body to the hotter. Every refrigerating system must have its point of heat disposal. In the industrial refrigerating plant, this is generally a cooling tower or spray pond where the warm water from the condenser wastes its heat to the surrounding air before returning again to the condenser.

The cost of refrigeration varies greatly with the refrigerating temperature and also with the temperature of the cooling water. It takes much more power to pump a given amount of heat if it has to be "lifted" more degrees. The first step in refrigerating economy, then, is to avoid too low a refrigeration temperature and too high a cooling-water temperature.

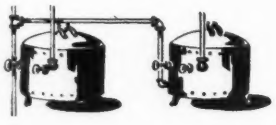
Space is lacking to discuss other aspects of the refrigerating problem, but it should be clear that the cost of this service can be greatly reduced by the use of modern equipment, expertly engineered and operated.

Dollars for Water

Sometimes city water is delivered direct to all parts of the factory by the pressure of the street main. Here there might seem to be little opportunity for the power engineer to save money. Such is not the case. By regularly recording the readings of the master meter, and of meters of important departments, it is possible to check waste, whether it be due to careless use or leaks.

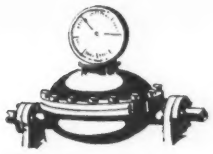
Where water consumption is large it may pay to consider local supply from streams, lakes or deep wells. Special equipment for purifying the water supply is frequently needed for the boiler water, and may be extended to include the entire plant supply.

The treatment of water supply for a variety of uses is an extremely specialized and complex branch of engineering. Avoid nostrums, and engage the best engineering talent to handle the chemical problems. Also use pump experts to design the pumping system, if much pumping is involved.



WATER SUPPLY IS A POWER SERVICE

WHO
PAYS THE FREIGHT
ON THE
POWER SERVICES?



METER STEAM, WATER, AIR, REFRIGERATION

PRECEDING articles have dealt mainly with the buying or local production of the power services. These services, as has been pointed out, are all characterized by the fact that they pass as fluids from the point of production to the point of consumption. All require specially prepared highways, as follows:

Highways	Services
Wires	Electricity
Shafts, Belts, Gears	Mechanical Power
Pipes	Steam Water Compressed Air Refrigeration
Ducts	Heating Air Ventilating Air Conditioned Air

It is not always realized by those who need not struggle daily with the operation of these transportation systems that they are in a way as elaborate as a railroad system, and involve almost as many problems of roadbed, traffic regulation, etc.

Piping Systems

Yet piping systems are subject to leaks to the air, and through valves. Traps may and do leak. Heat leaks out of steam pipes and into refrigeration lines through defective insulation. Regulators must hold pressure and temperature constant at the application point under a variety of conditions. Instruments must read temperatures and pressures. Meters must measure flow and consumption. Too small pipes choke traffic with excessive friction; too large pipes waste in fixed charges.

The proper layout, construction and operation of the piping system involves much engineering knowledge. It pays the factory to keep its power-service highways in shape, just as it pays a railroad to keep its roadbed well ballasted, its signal system in order and its bridges strong.

The best judge of what is needed is the engineer himself. He should be allowed full leeway in the maintenance and operation of this system. His experience may show him that certain more costly forms of insulation, joints, packing, fittings, valves, regulators and traps save money in the long run, through the elimination of waste and reduction of maintenance expense. It is poor economy to buy such items on a simple basis of first cost.

A good example is found in insulation. A bare steam pipe will take only about three months to waste in fuel the entire cost of a high-grade insulation job, including labor and materials. Poorly designed traps also are particular sinners, in that their waste is hard to detect, and is therefore often overlooked.

Perhaps the most important consideration of all, in piping system for the distribution of steam, water and compressed air, is adequate metering. The consumption of each principal manufacturing department should be metered and charged each month. The common practice of lumping power service costs together, and distributing arbitrary fractions to manufacturing departments, leads to tremendous loss. It is human nature to waste when responsibility for consumption is removed. In many cases the mere metering and charging of power services will cut consumption from 20 to 40 per cent.

Mechanical Transmission

Similar waste occurs in the transmission of power mechanically by shafting, belting and gears. Unless carefully laid out and aligned, provided with low-friction bearings and belts of proper tension, long lines of shafting continually turning will waste large sums in friction power and high maintenance. The problem of mechanical transmission calls for expert handling, particularly to utilize the remarkable advances that have been made recently in this field.

Careful consideration should be given to the advantages and disadvantages of the various types of unit drive and group drive. It is dangerous to make a hobby of "all-electric" or "all-mechanical" drive. In the majority of cases a combination of the two is better than either alone. Motor applications, in particular, call for expert handling. They should be superintended by a man fully acquainted with mechanical as well as electrical problems.

Finally, it is not enough to make the power engineer responsible only for the generation of power services. His responsibility should carry through to the point of consumption in the factory. His job is not merely to make, but to *deliver,* power services of the best possible quality and at the lowest possible cost.

SHAFTS, BELTS, PULLEYS, HAVE A NEW TECHNIQUE

SAVING POWER DOLLARS

A SUMMARY

1. "Fifty cents of every power service dollar is wasted." This statement is not far wrong as applied to American industry today. The blame must rest largely on the non-technical top industrial executive who either fails to employ a competent engineer, or refuses him that authority to act which must go with responsibility for results.

2. In industry, the "power house" is only a fraction of the "power plant." Think of the power plant in terms of the "power services": steam, electricity, mechanical power, water, refrigeration, compressed air, heating and ventilating, air conditioning. The power plant extends throughout the entire factory, because it includes all equipment used to generate, transmit and apply these services. Make one man responsible for this power plant.

3. Do you generate your own power? Do you buy power? Was your choice based on a detailed survey by an independent expert in this field? Millions of dollars are wasted annually through the failure of executives to appreciate the complexity of this problem and to approach its solution with expert aid and an open mind.

4. In buying power make sure that you operate under the best available rate schedule. See that plant personnel, and the mechanical and electrical equipment, are set to avoid the dollar penalties which schedules impose upon low power factor and demand peaks.

5. What is your boiler-room over-all efficiency in per cent? Eighty per cent is good, seventy is fair, sixty is bad and fifty something to blush about.

6. Be sure you have made the best choice among coal, oil and gas fuel. When installing new fuel-burning equipment, select equipment that will allow the maximum freedom of fuel choice. Thus you can snap up future fuel bargains when they appear. It sometimes pays to buy "poor coal" if you know how to select it and have the right kind of equipment to handle it.

7. Earmarks of an efficient boiler room: Plenty of light and air, intelligent operators, mechanical coal and ash handling, mechanical firing, mechanical draft, high-set boilers and not too many, an adequate installation of meters and instruments and automatic control, hot and scale-free feed water.

8. Common decency, as well as the trend of public sentiment and law, makes it essential that all new boiler-room equipment be designed to prevent emission of smoke, cinders and dust.

9. Large central stations require from 1 to 2 lb. of coal to produce one kilowatt-hour, with a national average of 1½ lb. The small industrial plant, generating power entirely as a by-product of heating steam, can produce a kilowatt-hour with ½ lb. of coal. On the other hand, the industrial plant exhausting to atmosphere may consume from 3 to 6 lb. of coal per kw.-hr. For this reason, the size of the heating and process-steam load is often the determining factor in deciding whether to make or buy power. Consult a disinterested expert.

10. The diesel engine consumes less fuel heat per kilowatt-hour than any steam plant except one generating "byproduct power." Relative costs of power from steam and diesel engines depend on relative prices of coal and diesel oil and on many other factors. Sometimes the diesel is cheaper and better, all things considered, and sometimes steam. A combination steam-diesel plant may be best of all.

11. Overheating is the direct cause of large waste of heating steam. Thermostat control, orifice control, vacuum operation, all help to reduce this loss. Consider unit heaters for large open spaces.

12. Ventilating and air conditioning are specialties. Consult specialists for the best service at lowest cost.

13. Refrigeration costs are controllable. Avoid too low a refrigeration temperature; it costs more. Avoid waste caused by inadequate cooling towers and ponds.

14. Water is a power service. Its production, transmission and application should be a responsibility of the power engineer. Water costs may be reduced by metering and charging manufacturing departments for actual consumption, and by the use of efficient pumps.

15. Transmission and application of the power services is a great field for savings. First comes piping for steam, water, refrigeration, compressed air. Avoid leaks of the fluid conveyed, also heat leaks through inefficient insulation. Metering will invariably reduce consumption.

16. Executives are gradually learning that neither "all-mechanical" transmission nor "all-electric" is generally best. In most cases a combination is better than either alone. Avoid the faddist; lean on men who understand both mechanical and electrical problems.

It is not expected that the foregoing pages will transform general executives into power engineers. The only hope is that this presentation will broaden the executive conception of the power job and thereby insure the engineer fuller cooperation in the big task ahead—saving American industry the hundreds of millions of dollars now lost annually in preventable power waste

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SIDELIGHTS

OF THE A.S.M.E. ANNUAL MEETING

THE fourteen pages that follow report technical sessions of the annual meeting of the American Society of Mechanical Engineers at the Engineering Societies Building, New York, N. Y., Dec. 4-8, Registration totalled about 2,000, practically the same as last year.

Principal technical sessions of interest to power engineers, reported in these pages, are: Tuesday: Heat Transfer, Fuels, Water Measurement; Wednesday: Industrial Power, Lubrication, Oil and Gas Power, Heat Transfer; Thursday: Central Station Power, Air Conditioning, Boiler Feed Water.

Particularly helpful was the session on Industrial Power, in which representatives of central stations and private plants vigorously debated the complex problems of engineering and economics involved in power interchange. Following the general session, the Industrial Power Conference Group held its usual private luncheon.

New sessions of this year's meeting included two on heat transfer and one devoted to air conditioning. Great interest was shown in the symposium on water measurement. A special ceremony at Stevens Institute honored the memory of Frederick L. Taylor, the "grand old man" of scientific management.

A tendency toward papers of broad coverage was noted at the meeting. Many dealt with various problems of education. Plans progressed for integrating the activities of engineering societies and promoting the welfare of the profession.

In particular, the present national economic situation received concentrated attention. The problems of recovery were discussed again and again by the management group. These same problems held the center of the stage at the annual dinner and in the Henry Towne Lecture.

The principal speaker at the annual dinner was Hon. John Dickinson, the Assistant Secretary of Commerce. This dinner, dedicated to the 1,000 new members of 1933, included the usual ceremonies, presentation of the 50-year members, the award of medals, and brief speeches by Dean A. A. Potter, outgoing president of the Society, and Paul Doty, newly elected president.

The A.S.M.E. Gold Medal was awarded to Dr. Ambrose Swasey of Cleveland, and the Worcester Reed Warner Medal to Dean Dexter S. Kimball of Cornell. Dr. Swasey was honored for his work in advancement of the engineering profession, his invention of the turret lathe, his initiation of the Engineering Foundation and his contribution to the astronomical telescope. Dean Kimball was honored particularly for his achievements in industrial management and engineering journalism.

William E. Caldwell of United Electric Light & Power Company was awarded the Melville Medal for his paper, "Characteristics of the Large Hell-Gate Boilers," originally published in *Power* in July, 1933.

Interpreting present-day Washington initiative in terms of national economic results, Dr. Dickinson pointed to a definite economic improvement and said that the greatest immediate need is further revival of the capital goods industries.

"The human engineer," he said, "must consider the perversities of human nature, hence the statesman must often work in an opposite direction to reach his goal. Recognition of this fact will help engineers to understand the recovery program.

"From now on," said Dr. Dickinson, "a permanent policy of well-timed public works is essential to prosperity. A repressive attitude toward government expenditures may be disastrous to the whole economic system."

The Henry Robinson Towne lecture, tradition of the annual meeting, was delivered this year by David Cushman Coyle, consulting engineer of New York. The lecture, as usual, dealt with economic problems, but the conclusions and treatment were entirely out of the ordinary.

In a closely reasoned and concise paper, Mr. Coyle arrived at far-reaching conclusions regarding the causes and cure of this and other business depressions. These conclusions were, in many points, diametrically opposed to those of most business men and practically all financiers.

Notably, he concluded, that many financial and monetary practices commonly denoted as "sound" are actually unsound in that they lead inevitably to economic disaster. Conversely, he declared that certain so-called "unsound" practices are essential to permanent prosperity.

Depressions, according to his view, are caused by the rising tide of debt and are cured when that debt is wiped out by bankruptcy or inflation. This time, he pointed out, the government has not dared to take the bankruptcy cure. It is, therefore, necessary to depend upon some sort of inflation, either of the Wall Street or of the government controlled variety. The former he pictured as leading to certain disaster, while the latter might be kept under control. The former, he said, is of the type usually referred to as a "sound money inflation."

Among the radical measures urged by Mr. Coyle were increases in the upper-bracket income tax and government ownership of the transportation and electric utilities. He said that non-liquidating public works are sounder than self-liquidating, since the former do not pile up a burden of future debts.

DETROIT EXPERIMENTS SHOW THAT

1,000-DEG. STEAM IS FEASIBLE

Experience with the experimental 10,000-kw., 1,000-deg. turbine at Detroit Edison Co.'s Delray No. 3 plant, related at the Central Station session. Other papers deal with super-saturated steam and leaving velocity and exhaust losses in steam turbines

SINCE 1929, when it was first learned that Detroit Edison Co. was embarking upon an experiment in the use of steam at 1,000 deg. F., engineers have looked forward to the time when sufficient experience would be obtained to warrant presentation of the data secured. Results and experience so far obtained with 1,000-deg. steam were presented at the Central Station session in two papers, one dealing with the thermal performance of the 10,000-kw. unit at Delray No. 3, the other relating experiences with high-temperature steam at both Delray and Trenton Channel, especially regarding its effect on materials used in the two experimental units.

THERMAL PERFORMANCE OF DETROIT TURBINES

Many tests have been made to determine the thermal performance of the 10,000-kw. turbine generator designed for 1,000 deg. steam temperature, at the Delray plant. Results were presented by W. A. Carter and Prof. F. O. Ellenwood.

The energy consumption of the complete unit (turbine generator and three water heaters), was 10,730 B.t.u. per kw.-hr. for a load of 10,000 kw., with a throttle pressure of 390 lb. per sq.in. abs., and a temperature of 1,000 deg. F., exhausting at 1 in. abs. This means a thermal efficiency of 31.8 per cent, and an engine efficiency of 76 per cent for the complete unit.

Increasing the steam temperature from 700 to 1,000 deg. reduced the energy consumption of this unit 920 B.t.u. per kw.-hr., or 7.9 per cent.

Radiation and convection losses from the turbine and heaters with 1,000-deg. steam were relatively small, namely, 0.6 per ent of the available energy for a load of 10,000 kw.

The loss due to the leakage of sealing steam was relatively large, namely, 4.4 per cent of the available energy for full-load conditions. This is probably not an inherent characteristic of large turbines designed for 1,000-deg. steam.

Over-all coefficients of heat transfer in feedwater heaters that received highly superheated steam in these tests appear to be very high, relative to those obtained when saturated steam is used. This, however, is based on using nominal temperature difference, in which the temperature of the steam is considered at the temperature corresponding to its pressure.

HIGH-TEMPERATURE STEAM EXPERIENCE AT DETROIT

EXPERIENCE with the materials used in the two high-temperature installations in Detroit, one a superheater installation at Trenton Channel, and the other a 10,000-kw. turbine-generator and superheater at Delray No. 3 Power House, was presented by P. W. Thompson and R. M. Van Duzer, Jr. These authors believe that design and construction of steam-generating plants using 1,000-deg. steam is entirely feasible. The Trenton Channel installation has operated 23,000 hr., 21,169 at 1,000 to 1,100 deg. F. The turbine-generator installation at Delray No. 3 power-house has been in service 11,231 hours, 7,832 at 1,000 deg. F.

Austenitic 18 per cent Cr, 8 per cent Ni alloy, was used in the Trenton Channel apparatus, with the exception of Cr-W-V flange bolts and low-carbon steel tubes in the cooler portion of the superheater. Likewise, the 18-8 material was used for piping and for hotter portions of the Delray superheater, notwithstanding reports received from abroad of serious failures after the Trenton installation was placed in operation. Examination of the austenitic 18-8 per cent alloy showed that the material had deteriorated in service, probably due to precipitation of chromium carbide along the boundary. There is, however, no evidence thus far of inter-crystalline corrosion, and no such serious reduction in physical properties as would lead to rejection of this material for steam service in the 1,000 to 1,100-deg. range.

Other materials used in the Delray installation, and later as replacements at Trenton Channel, include steel in the so-called low-alloy group, possessing fairly good high-temperature properties, and having better fabricating qualities and lower cost than the austenitic alloy. These steels consisted of more than 6 per cent Cr, 1 per cent W, from which three castings and a piece of tubing were made; a steel casting from ½ per cent Mo; a valve body from 0.85 per cent Mo and low-, medium- and high-carbon calorized steel. The high temperature parts of the turbine were made of a 0.30 C, 3.1 Ni, 0.35 Cr, 0.35 Mo alloy, while turbine nozzle sections were made from 0.25 C, 14.0 Cr stainless steel, excepting the firstwheel blading, which was a 0.47C, 11.8 Cr, 36.3 Ni steel.

Results of examinations made on various materials from both installations show that some changes have taken place. Loss of strength or tendency toward embrittlement has not progressed to such an extent that consideration has been given to the replacement of any parts. Examination of three Rezistal castings, one of which cracked in service, showed these parts all in poor condition because of inclusions and blowholes originally present. The result of tests on a 4 to 6 per cent Cr, 1 per cent W valve body, after 12,995 hours of service, showed no embrittlement. An investigation conducted on the Ni-Cr-Mo turbine material likewise disclosed no tendency toward embrittlement. The Cr-W-V bolting material used in most of the bolted joints is not entirely stable. Its use, however, has been continued, as less joint maintenance has been experienced with it than with other steels.

Nitralloy seat rings removed from two different valves were badly scaled and softened, indicating that this alloy is unsuited for high-temperature valve trim. Experience to date with calorizing would indicate that this treatment does offer some degree of protection to the surface of carbon steels.

The original Trenton Channel pipe joints, all designed to the 600-lb. A.S.A. flange standard, have proved inadequate because of a high working stress and stresses caused by thermal expansion. Later, heavier designs have given a little trouble. Welding, however, appears to offer the most possibilities for future pipe-joint design.

With the exception of the original pipe joints, excessive growth of calorized superheater tubes, and the turbine throttle valve, the creep resistance of all parts subject to high temperature has been satisfactory. Changes in diameter of three of the 0.3 to 0.4 C, 2½-in. steel tubes, and the three KA2B, 2¼-in. alloy tubes, observed during the last measuring period of 5,005 hours, indicates that the steel tubes are growing at an average creep rate of 4.4 per cent in 100,000 hr., while alloy tubes are growing at a corresponding rate of 5.3 per cent though carrying about twice the stress. A special measuring device was provided on the turbine to determine its over-all change in length, which was insignificant.

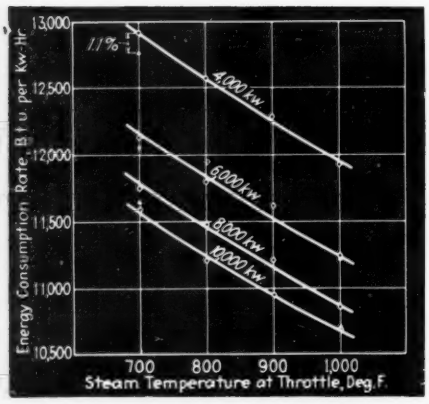
Turbine troubles have been: a leaky throttle bonnet joint, wear of all the shaft packing caused by rubbing during starting-up, and binding of the throttle valve steam. This latter difficulty was caused by the growth of a semi-steel packing sleeve. This bushing, as well as similar ones in the five control valves, has been replaced with nitralloy, which thus far has been satisfactory.

Operation of the two installations has presented no features particularly different from those encountered in equipment at lower temperatures, except in the starting procedure followed for the turbine in which 1,000-deg. steam is not used. The unit is started with 700-deg. steam and 30 per cent load applied before the temperature is increased. The same procedure in the reverse order is followed in shutting down.

Discussion

As both preceding papers considered performance of the same installation, discussion was concurrent. C. R. Soderberg remarked that efficiency had been sacrificed for reliability, the decrease in efficiency almost offsetting the advantage of higher temperature. A. G. Christie, on the other hand, said that the thermal efficiency reported was high for a unit of 10,000-kw. capacity. He agreed with the authors that better performance in larger units could be inferred by decreasing sealing steam leakage loss and drip losses, which amounted to 5 B.t.u. per lb. of steam. Several discussers suggested improvements to the high-pressure turbine glands which would shorten the gland by use of water seal for cooling.

H. J. Kerr pointed out that there was ample evidence that KA_2 steel gave good service under 1,000-deg. conditions and that a stabalizing heat treatment had been developed since the Delray installation that prevented carbide precipitation. In his experience, creep of this steel was less



Energy consumption rate of turbine-generator and three heaters

under the same temperature conditions than reported in the paper.

In H. Dahlstrand's opinion, metals for high-temperature service should be fully annealed. It is also his belief that it is unnecessary to use alloy steel for castings, as they can be designed for low stress. The use of Cr.-Mo. steel is due mainly to the desire for flexibility. By lowering the temperature to 950 deg., the cost of materials would be considerably reduced.

R. Brown disclosed that at the time of the Trenton installation calorized tubes were relatively brittle. They have found that by adding 0.5 to 1.0 per cent Mo., ductility is greatly improved.

SUPERSATURATED STEAM

The determination of the weight of steam which may be expected to flow through a given nozzle area under varying conditions is one of the most important applications of thermodynamics. In the case of saturated steam, the flow through nozzles often exceeds by as much as 5 per cent that estimated by the usual formula.

It has been suggested that in rapid expansion through a nozzle, steam may not condense when the saturated condition is reached, but may continue to expand as in the superheated region, thus becoming super-saturated. Research work was undertaken by John I. Yellott, and reported by him in a paper, "Supersaturated Steam," for the purpose of ascertaining whether supersaturation actually takes place in the expansion of steam through turbine nozzles. It was also desired to determine the size of the droplet in which condensation occurs in blowing steam, for it was believed that the size of the droplet might have an important bearing on the subject of turbine-blade erosion.

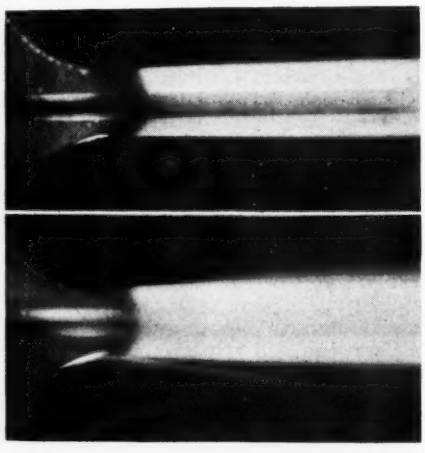
The apparatus consists primarily of a cast-iron channel, into the sides of which brass blocks can be bolted to form a rectangular nozzle of any desired shape. A glass plate clamped tightly to the channel forms the top of the nozzle and permits observation of the interior, which is illuminated axially by beams of arc light. It was found that the entering steam, superheated by throttling from the boiler condition, was quite transparent, and that any entrained moisture could be clearly seen. When condensation took place, however, the appearance of the steam jet changed, and the transparency of the superheated and supersaturated steam was replaced by a dense bluish fog.

Using a search tube and varying the initial pressure between 10 and 75 lb. per sq.in., abs., the static pressure of the steam was measured at the point where condensation was observed to begin. When plotted on the Mollier chart, the condensation points were found to lie along a line between the 3 and 4 per cent moisture lines. The droplet size was found to have a radius of about 6.2×10^{-8} cm.

Discussion

Prof. A. G. Christie pointed out that many new problems arose in the course of Mr. Yellott's work. Another graduate student, J. T. Rettaliata, is continuing this research in an endeavor to determine whether roughness of the nozzle wall surface is the cause of the abrupt halt in pressure drop at the moment condensation starts from the supersaturated steam. This hitch in the pressure drop curves was noted by both Prof. Robb and Mr. Yellott.

Top—Illumination of flow through nozzle confined to plane of search tube. Bottom—Search tube in place, entire cross-section illuminated



An attempt will also be made to investigate the pressures at which condensation starts with varying nozzle shapes. Mr. Yellott found no preliminary condensation with one of the nozzles, while with the other nozzle preliminary condensation was usually present. We believe that a nozzle can be built between these two limiting sizes in which the condensation would be either ultimate or preliminary depending upon the pressure conditions.

We also propose to try some actual turbine nozzles and to study both the supersaturation effects, the loss of contact of jets with walls, and the recompression in the issuing jet by means of light rays of definite wave length.

Other discussion suggested that the term "supersaturation" be changed to "under cooling."

LEAVING VELOCITY AND EXHAUST LOSS IN STEAM TURBINES

Importance of the leaving loss in a steam turbine, and the rapidity with which it increases at high load, causes it to be a determining influence in fixing the economic rating of a machine. The several elements necessary for an analysis are each evaluated in a fairly direct, although sometimes approximate manner, in a paper presented by Ernest L. Robinson.

The loss in question occurs in the exhaust hood between the last wheel exit and the exhaust flange to the condenser. It is made up both of kinetic-energy loss and of pressure loss through the hood, and each effect varies both with the load and with location around the wheel annulus. Curves in the paper give the total leaving velocity and exhaust loss for a typical 35,000-kw. turbine, with extraction for feed-water heating at full load, to be about 4.5 per cent.

Discussion

It was evident that there is a difference of opinion on what leaving losses should be. Prof. A. G. Christie agreed with the author that the combined leaving velocity and exhaust loss constituted the most important single loss in condensing steam turbines. These losses are fixed by the original design and are inherent in construction. They cannot be increased or decreased for given operating conditions by efforts of station operators. It is, therefore, incumbent upon plant designers to give fullest consideration to the economics of these losses in the initial selection of turbine equipment.

Several, discussing Mr. Robinson's paper, emphasized the necessity of considering turbine leaving losses in plant design. The opinion was expressed that it is not a question of how high or how low these losses are, but how they influence economical design of the plant and loading of the turbines. Where there is a wide range in temperature of circulating water between winter and summer months, this must be taken into account in turbine operation or leaving losses in the winter months may be many times greater than in summer.

NAVY ENGINEERS PROPOSE NEW

STANDARD SHIP BOILER COMPOUND

IN THE session devoted to feed-water treatment, a new standard boiler compound for Navy ships was proposed by Lieut.-Com. T. A. Solberg and Robert C. Adams, Jr., both of the U. S. Naval Experiment Station, Annapolis. Two other papers dealt, respectively, with the solubility of sodium sulphate, and with silicon found in boiler scale in western Oregon.

STANDARD BOILER COMPOUND

THE STANDARD Navy boiler compound proposed by Messrs. Solberg and Adams would contain 47 per cent of anhydrous disodium phosphate, 44 per cent of soda ash, and 9 per cent of cornstarch. This compound was recommended for the use of the fleet, with the expectation that necessary alterations in composition, to meet changing conditions, could be made from data available at the Engineering Experiment Station.

The present standard water treatment of the Navy is based on investigations made between 1909 and 1911 by Lieut.-Com. Frank Lyons. This treatment uses basic carbonate and phosphate. With increasing pressures during the last few years, it has been harder to maintain clean boilers with this treatment, hence the U. S. Naval Experiment Engineering Experiment Station has been testing the various commercial methods of boiler-water treatment for the purpose of developing an improved method for the use of the Navy.

The commercial methods were subjected to the standard test, which represented in an intensified form the worst conditions to be found in the service. Test was conducted at 350 lb. pressure, using Severn River water, which is in effect diluted sea water. Additional contamination included 70 parts per million of calcium sulphate, six parts per million of silica (water glass), and saturation with air. Continuous blowdown maintained the condensation of the boiler water in the drum around 70 grains per gallon of chloride. Doses of treating chemicals were added at 4-hr. intervals.

Four types of feed-water treatment, submitted by 11 different companies, were subjected to the comparative tests. These types were the colloidal, the coating, the electrolytic, and the chemical method. Corrosion results fortified the opinion long held by the Navy, that the maintenance of a suitable alkalinity is the backbone of successful boiler-water treatment.

The formulation of a new treatment, consisting of a single compound, for the entire Navy, was considered possible, because, with few exceptions, the feed water in all vessels of the fleet is distilled water.

The recommended compound, as already stated, consists of 47 per cent of anhydrous disodium phosphate, 44 per cent of soda ash, and 9 per cent of cornstarch.

SOLUBILITY OF SODIUM SULPHATE

IN MARCH, 1933, active work on a program of research, dealing with the solubility in relation to the sodium sulphate in concentrated boiler water salines, was commenced under the auspices of the joint Research Committee on Boiler Feed-Water Studies. The results obtained during the first six months were presented by W. C. Schroeder, research chemical engineer, and Everett P. Partridge, supervising engineer, Non-Metallic Minerals Experiment Station, U. S. Bureau of Mines.

SILICON FOUND IN BOILER SCALE IN WESTERN OREGON

IN THE river waters of western Oregon silicon dioxide constitutes approximately 25 to 40 per cent of the total dry residue, roughly four times the average for North America. These waters contain very little conventional hardness, and are generally regarded as an excellent quality, yet they form silicate scale. From experiments made with these waters, Profs. R. E. Summers and C. S. Keevil, of the Oregon State College, concluded that the best method of handling them is to retain the siliceous matter in solution in the boiler water. The necessary solubility of the silica is produced by adding sodium and maintaining pH values from 10.5 to 11 or 11.5. Sodium-phosphate treatment was said to be desirable from several angles.

DISCUSSION

The results of studies of the Winkler method for determining dissolved oxygen were presented by C. H. Fellows, chairman of Special Sub-Committee No. 8. Mr. Fellows is chemical engineer with the Detroit Edison Company. His report centered about the accuracy obtainable by this method and the effect of various techniques and various types of reagents.

Discussing this report, Mr. Yoder of the Cochrane Corporation indicated that its findings agreed in general with the work done by his company but not in all details. He said that an accuracy within .01 c.c. oxygen per liter is high enough for field work and is obtainable in practice. Mr. Yoder presented a chart giving corrections (based on temperature of solution) for oxygen introduced with the test reagents.

LAND PLANTS WARNED AGAINST NAVY COMPOUND

In the extensive discussion that followed the paper of Messrs. Solberg and Adams, practically every speaker pointed to the danger that operators of plants on land might attempt to use the proposed new Navy compound. Commander Solberg himself warned against any such application, saying that it would be worse than useless to attempt to apply the Navy formula to any other boilers than those of the ships of the fleet. Even the merchant marine could not, with safety, use this formula.

In his closure, Commander Solberg said that this latest study was started because the Navy wished to free itself from the use of proprietary treatments, in order that it might buy treating chemicals on a competitive basis. The formula may be modified after a year of experience.

LUBRICATION—

NEW THEORY AND PRACTICE

LUBRICATION engineering and research were accorded considerable attention in a session devoted to each of the subjects.

In very high-speed bearings, the oil film may build up in such a way as to cause shaft whipping, due to oil action in the journal bearings. This action has been termed "oil-film whirl," and is a resonant motion, building up in general when a shaft runs at twice its lower critical speed, or any higher speed. This action and a non-whirling bearing were discussed in "Oil-Film Whirl—A Non-Whirling Bearing," by B. L. Newkirk and L. P. Grobel.

Investigation of the action of oil-film whirl has resulted in development of a bearing which, generally speaking, does not develop whirl. This bearing has grooves that utilize the rotating-shaft's pumping effect to build up oil pressure in the bearing top. A maximum pressure of 180 lb. per sq.in. was developed at the end of an oil groove 0.03 in. deep.

HEAT EFFECTS IN LUBRICATING FILMS

"HEAT EFFECTS in Lubricating Films," by Albert Kingsbury, treated of the internal

(Continued on Page 785)

WATER MEASUREMENT SYMPOSIUM

FEATURES HIGHER ACCURACY

Gibson, photoflow, salt-velocity and current-meter methods of measuring flowing water were presented in eleven papers at two sessions. One of them described a new method of applying pitot tubes in making water measurements, another the application of current meters to testing the 42,500-hp. Safe Harbor units

IF THERE ever was any doubt about the importance of water measurements, it was dispelled when 200 hydraulic and research engineers assembled at two sessions on water-measurements to hear 11 papers presented on different methods of measuring large volumes of water in closed conduits. The dominating theme of these papers was how to obtain a higher degree of accuracy. Standard methods were carefully scrutinized for possible slight errors and practices suggested to eliminate them. New ways of applying old methods to insure a high degree of accuracy also had a prominent place in the program.

GIBSON METHOD OF WATER MEASUREMENT

LIMITATIONS of various methods of measuring water including the Gibson method are discussed in, "Concerning the Degree of Accuracy of the Gibson Method of Measuring Flow of Water," by Dr. D. Thoma. The Gibson method is applicable for measurements in closed conduits and is founded on pressure rise which occurs in such conduits when flow is brought to rest. Neglecting friction, Dr. Thoma demonstrates that the magnitude of momentum contained in the pipe is dependent only upon the flow of water per second through the pipe and that the fundamental equation upon which Gibson's deduction is founded is rigorously true. Having proved the fundamental equation, Dr. Thoma proceeds to discuss the possibility of four small errors in the application of the method. These are:

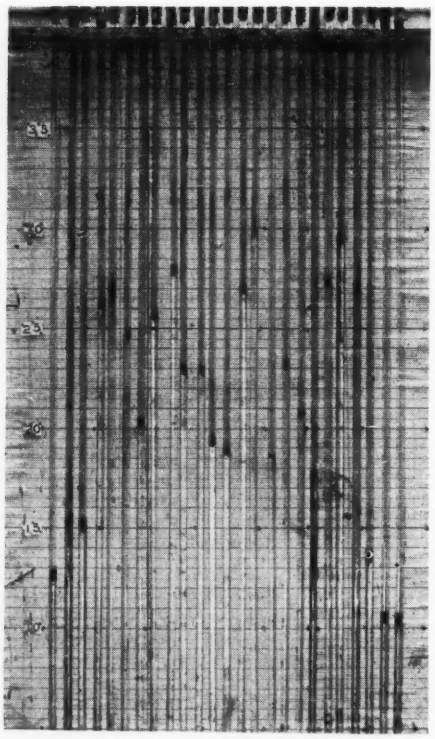
(1) Accessory motions or extra currents due to turbulence. (2) False valuation of friction in the conduit during gate closure. (3) Friction of the mercury column. (4) Inertia of the mercury column. The first two are regarded as about 1 per cent in magnitude and are negative and positive, respectively. The last two are of opposite sign also, but are of the order of 0.5 per cent. Doctor Thoma concludes that errors (1) and (2) are determinative in fixing the accuracy of the measurement and that in its existing from the accuracy of the method under favorable circumstances is approximately equal to current-meter measurements taken with great care under favorable conditions, the error of which he considers may be of the order of 1 per cent.

In discussing Dr. Thoma's paper, N. R. Gibson and E. B. Strowger, give a detailed proof of the fundamental equation applying to the method and discuss the effect of friction and accompanying accessory motions with respect to the simple diagram, and also the differential diagram. It is shown that where the measuring sections are equal, or nearly so, and where the upper measuring section is located at a reasonable distance from the inlet, the differential diagram is independent of accessory motions. Test results on a long pipe are shown where both kinds of diagrams were taken and where the agreement between the two is within 0.2 per cent. It is pointed out that this leads to either one or two conclusions. Either positive and negative errors of both simple and differential diagrams are equal and cancel one another or leave the same residual, or Dr. Thoma's estimates of these errors are too large. It is also shown that when the differential method is used, errors No. 2 and No. 4 are small and are opposite in sign to error No. 3 which makes the resulting residual error, if any, very small.

PHOTOFLOW METHOD OF WATER MEASUREMENT

DR. WILLIAM M. WHITE, and William J. Rheingans, in "Photoflow Method of Water Measurement" describe a method of putting pitot-tube measurements upon a more exact basis. The Photoflow method is the photographic record of the differences in pressures of pitot-tube points positioned throughout the cross-section of flow, and piezometer connections positioned to indicate the pressure across the section of flow.

Actual volumetric calibration of the Photoflow method under extremely disturbed and turbulent conditions of flow established a coefficient of 0.971 for these conditions, which represents about the lower limit of pitot-tube coefficient, no matter how turbulent the flow. The results of a large number of calibrations with a known velocity flowing and with properly constructed piezometers have in the past shown coefficients of pitot-tube measurements of about 0.976 as most generally applicable for normal flow conditions. The authors claim that the adoption



Photograph of pitot-tube and piezometer readings during test on pumping station made by Photoflow method

of 0.976 as the coefficient for use with the Photoflow method will give an accuracy of one-half of 1 per cent because of the narrow range limit of the coefficient for different conditions of flow.

Observations on water flow in conduits show that although the quantity flowing past any section may remain unchanged, the velocity at any one point in this section may vary widely. Tests with the Photoflow method show that in turbulent flow, variation in velocity at one point may be as much as 30 to 40 per cent, without the least change in quantity flowing past the measuring section. The Photoflow is not affected by such variations in distribution of flow, because it measures all the velocities simultaneously and thereby makes a true record of flow across the entire section at any particular instant.

WATER GAGING

ONE OF THE MOST important papers presented was "Water Gaging for Low-Head Units of High Capacity," by J. M. Mousson. The paper discussed the status of the current-meter in Europe at time it was selected for testing the 42,500-hp. units in the Safe-Harbor plant on the Susquehanna River and application of the two-type meter method. It shows how this method was originally applied and

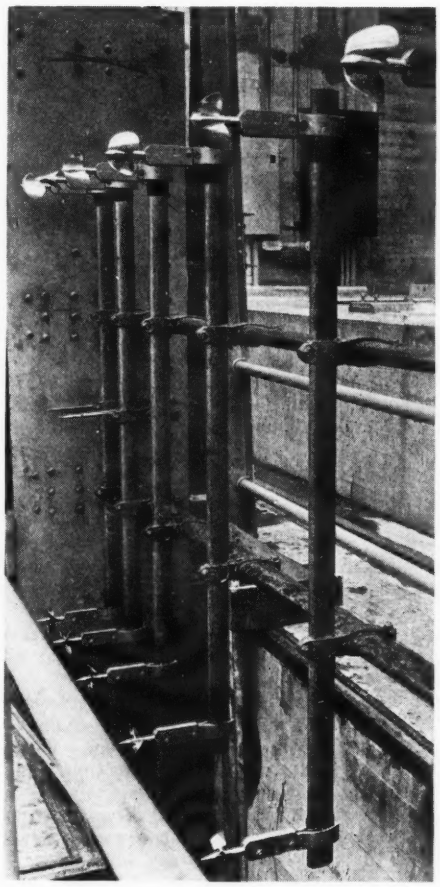
how certain modifications were made for increasing reliability and decreasing the time and effort required for making tests. These made possible new methods of compilation which have been developed to greatly facilitate this phase of the testing program. Successful application of these methods should make current-meter measurements more feasible than before.

In preparation for these tests, elaborate investigations were conducted at the Bureau of Standards and elsewhere to determine characteristics and limitations of meters under various conditions of uniform oblique, pulsating, and turbulent flow.

It has been shown that water passages with parallel sides for metering do not insure parallel flow, and that even under as nearly ideal conditions as is practical to secure, the use of two types of meters will indicate an effective angularity. However, it is believed that accurate measurements of oblique flow can be made by the use of two types of meters, each affected to a different extent by angularity. Use of this method will greatly enlarge the field of current-meter testing.

There were pointed out advantages of making index tests in conjunction with current-meter measurements; not only to extend them to a wide range of operating conditions, but also as a measure of consistency of discharge measurements.

At the present stage of development in the art of water measurement, it is believed that economies which may be achieved through improved testing procedure and through omission of temporary installations, as well as the possibility of gaging discharge under operating conditions, make the current-meter method more attractive and economically more feasible. It is the author's hope that the record of the Safe Harbor tests, as outlined in this paper, will contribute to a better understanding of problems involved in water gaging by current meters. Since in recent hydro-electric construction in the low-head field there is a marked tendency toward further shortening of water passages, which may render other methods of measurements more difficult, a careful study of current-meter methods is therefore at this time, very desirable.



Safe-Harbor current-metor support frame, Type 1 and Type 2 meters mounted simultaneously

HOW WATER FLOWS IN A PIPE LINE

FOR THE LAST YEAR or more, work has been carried on at the Alden Hydraulic Laboratory to obtain a mental picture of how water flows in a pipe. The results of this work were given in a paper, "How Water Flows in a Pipe Line," by Prof. Charles M. Allen. Investigations were made by continuously injecting brine through a small tube into a pipe line at a given point upstream from several individual electrodes spaced uniformly across the pipe.

For this investigation, the lower end of the 40-in. riveted steel penstock supplying water to the main laboratory was used. At each station, two taps were made in the penstock so that two traverses for the injection of the brine could be made. These traverses were on diameters 90 deg. apart. In order to determine the amount of spread or dispersion of the brine, 21 individual pairs of electrodes were mounted upon a frame and permanently installed in the penstock, 350 ft. below the head gate. The brine injection stations were 5, 11.2, 20, and 45 ft. above the electrode station. Pitometer traverses were made at both upper and lower ends of the 45-ft. test section and were found to be identical.

The conclusions reached are that the dispersion of the salt solution is surprisingly large, especially in the shorter sections; amount of dispersion is comparatively constant for all positions in the traverses except those close to the wall; amount of dispersion is comparatively constant for the range of velocities used; no apparent effect on dispersion due to difference in specific gravity of the salt solution and water is shown; assumptions of streamline or parallel flow apparently should not be made for ordinary penstock conditions.

CURRENT-METER BEHAVIOR IN TURBULENT FLOWING WATER

"RESEARCH Investigations of Current-meter Behavior in Flowing Water" was presented by S. Logan Kerr. Very little published literature is available on current-meter behavior in turbulent flowing water, and the few tests which could be found are not directly comparable with conditions existing in hydraulic-turbine metering sections. As a result of this lack of complete information, a series of experiments were conducted in the I. P. Morris hydraulic laboratory to observe the behavior of two types of current meters in a closed conduit with smooth flow and also with turbulent flow. Conclusions drawn indicate:

1. The so-called Type-1 Ott meter, which in still water has a tendency to under-register in oblique calibration, checks within one per cent in smooth flowing water free from artificial turbulence. The general tendency of the meter is toward slight over-registry, as compared to still-water rating.

2. The Type-1 meter in turbulent flowing water as existed in the testing flume, indicates a distinct tendency to over-register, as compared with either still-water ratings or with registration of the meter in smooth flowing water, and determinations made with varying degrees of turbulence indicate from 2 to 4 per cent over-registration with excessive turbulence.

3. As a result of these investigations, it may be concluded that the Type-1 Ott meter should be used only in smooth rectangular sections at a sufficient distance downstream from any obstruction to secure flow free from artificial turbulence. Under these conditions precise flow measurements, accurate to within approximately 1 per cent, may be expected.

4. Where turbulence exists without angular flow, the Type-1 Ott meter seems to have a definite tendency to over-register and the error in the measurement may be from 2 to 5 per cent, depending upon the local conditions.

5. With angular flow combined with turbulence, the accuracy of any current-meter measurement is extremely doubtful.

CURRENT METERS FOR PRECISE FLOW MEASUREMENTS

DR. A. OTT, in "Observations on the Use of Current Meters for Precise Flow Measurement," pointed out that among the circumstances leading to the advanced development of current-meter construction and use in Europe were certain favorable factors including early adoption of the propeller-type meter with axis parallel to flow, in preference to the cup-type having axis normal to flow, thus avoiding unprofitable controversies; the fortunate circumstance that such an authority as Dr. Epper, chief of Swiss Hydrographic Office, was available to guide the development; and willing cooperation of an experienced firm of manufacturers of water-measuring equipment. Among important steps in the application of current meters to precise water measurement for testing large power plants were use in parallel of a plurality of meters, the adoption of simultaneous electric recording by chronograph, consequent adoption of water-free contact mechanisms, elimination of multiplicity of meter types and standardization of practice.

The degree of accuracy actually obtainable in practice with current meters in Dr. Ott's opinion, appears to be still not entirely clear, in spite of numerous comparative tests already made, including direct volumetric measurement. That is not surprising, since the checking of accuracies of measurement of more than 99 per cent is a very delicate matter.

IN A PAPER "Use of Current Meters for Precise Measurement," by the late Floyd

A. Nagler, the opinion was expressed that a reliable current meter gives an accurate indication of velocity of only a single filament of flow in the cross-section of a stream. Precise flow measurements can be obtained only with proper use of the current meter in scanning variations in velocity over the entire section, just as images are reproduced by single points in telephoto and television technique.

ACCURACY OF CURRENT METERS

FACTORS that influence the accuracy of current-meter measurements are type of meter, rating of calibration of meter, gaging section, and method of measurement, said Carl Rohwer, in "Factors in Accuracy of Current-Meter Measurements." Each of these factors is important and should be given consideration in order to increase the accuracy of current-meter measurements.

Meters in use at the present time are either of the cup or propeller type. Cup meters have a vertical axis around which cups are concentrically arranged. Unequal pressure on opposite sides of the cups causes rotation. Propeller meters have a horizontal shaft to which is attached a helicoidal-blade propeller. Rotation of the propeller is produced by water pressure on the blades. Of the two types, Price cup meters and Ott propeller meters are most extensively used in the United States, but Hoff meters, which are the most recent propeller-type developed, are gaining popularity.

Comparisons of current-meter measurements with other methods of measurements have demonstrated, in Mr. Rohwer's opinion, that accurate measurements can be made with them under favorable conditions. Many of the current-meter measurements differ from the check measurements by less than 1 per cent, and few tests are more than 5 per cent in error. These tests show also that either cup or propeller meters will give satisfactory results when measurements are carefully made.

CURRENT-METER PERFORMANCE

JOHN C. HOYT told, in "Current-Meter Testing and Performance," how engineers of the Water Resources Branch of the U. S. Geological Survey use current meters in the operation of over 2,800 river-measurement stations on various streams. Over 25,000 measurements of discharge are made annually, in which not less than 1,000,000 independent determinations of velocity are made.

In the work of the Water Resources Branch, the Price meter, which is of the differential type, is used almost exclusively. This meter was designed in 1882 by G. W. Price, then assistant engineer, Corps of Engineers, U. S. Army. The meter now in use closely follows the main design of the first model—no changes have been made in it during the last 25 years that have altered its essential accuracy and consistent operation in actual field use.

DR. W. HAHN, in "Water Measurement With Current Meters in Hydraulic Turbine Plants," emphasized the reliability of the current-meter method of measuring water, when properly applied. For hydraulic-turbine tests all personal and other errors must be eliminated and in Dr. Hahn's opinion the only measurements that can be considered reliable are those in which the revolutions of the current meters are recorded automatically by a chronograph. Then the time for making the test will also be greatly reduced. For instance, it is possible to make a test in a large metering section, requiring measurements at 10 different elevations, in about 15 to 20 min. if the measuring equipment is properly designed.

With a fair amount of experience, it takes about 2 to 3 hr. to evaluate a water measurement in a penstock with 30 measuring points, and it takes about 5 hr. to evaluate a water measurement of 100 measuring points in a rectangular metering section.

DISCUSSION

In discussion, attention was called to the wide variation in rate of flow that may occur at any one cross-section of a closed conduit, when water is flowing to a turbine under a steady load, and the effects that this may have on the accuracy of some methods used for measuring flow of water. With a properly designed pitot tube in an ideal fluid, an accuracy of over 99 per cent can be obtained. In an actual fluid if flow is streamline, the accuracy is also high, but if flow is turbulent then the accuracy probably would not exceed 97.5 per cent. A coefficient for the pitot tube as low as 0.93 with a flow angle of 40 deg. was mentioned. It was suggested that such angles of flow are not encountered in practice and that the maximum angle does not usually exceed 5 or 6 deg. Under this condition, the pitot tube would give accurate results, especially with a new type tube now available.

A great deal of discussion was centered around accuracy of the current-meter method of measuring flow, particularly the two-meter method used at Safe Harbor plant. It was pointed out that the Allen salt-velocity and the Gibson methods of measuring water in closed conduits are the most accurate yet devised. Emphasis was placed upon the necessity of any method being used by those thoroughly familiar with its technique of application. In the hands of experts, any recognized method will give accurate results.

In calibration of current meters, attention was called to how the same results are not obtained when checking meters for angular flow in still as in running water. It was suggested that probably current meters could be further improved to increase their accuracy in turbulent flow.

At Safe-Harbor plant, to determine the effects of the rack structure on the accuracy of the current meters, the structure was removed on one unit and a test made. These results checked to within 0.2 of one per cent of those obtained with the racks in place. Tests were also made by the Gibson method with racks in place and with them removed. The two-current-meter method checked within 0.7 of one per cent with the Gibson method when the rack structure was removed and within 0.9 per cent with the rack in place. From this it is assumed that the two-current-meter method gives accurate results.

Contrary to what is generally believed, it was brought out that current meters have been used quite extensively in the United States for water measurements in waterwheel testing. One waterwheel manufacturing company has records of 46 of its installations, representing a total of 330,000 hp., that have been tested with current meters.

ORIFICE DISCHARGE COEFFICIENTS OBTAINED FOR LIQUIDS AND GASES

"ORIFICE Discharge Coefficients for Viscous Liquids" by G. L. Tuve and R. E. Sprenkle, presented and correlated data on aplication of the square-edged orifice for metering flow of viscous liquids in small pipes. A typical use for such data is in controlling oil-fired metallurgical, industrial, or boiler furnaces, where meters must be accurate in spite of variations in flow and in viscosity and density of oil.

Calibration data cover about 500 experimental determinations of discharge coefficients made during the last three years at Case School of Applied Science, with the cooperation of Bailey Meter Company. These determinations cover the viscous, the critical and lower turbulent ranges, using eight sizes of orifices, with liquids in the range of viscosities between that of water and that of an oil of 7,500 sec.

FOR SHARP-EDGED ORIFICES

Results of tests made more accurately to determine coefficients of discharge of sharp-edged orifices in various sizes pipes, done under the auspices of a Joint Committee of The American Society of Mechanical Engineers and the American Gas Association, were presented by S. R. Beitler, in "Discharge Coefficients of Sharp-Edged Orifices." Orifices from $\frac{1}{8}$ in. to 12 in. in diameter with diameter ratios of from 0.04 to 0.84 were tested in commercial pipes of from 1 in. to 14 in. in diameter. Pressures were taken to determine the coefficient for most of the different types of taps now in use commercially. Orifices tested were of various thicknesses and with various arrangements of downstream orifice edge, the upstream edge being kept square and sharp at all times.

Curves are presented showing coefficients for various pipe sizes and for diameter ratios of from 15 to 80 per cent. These coefficients are for the Reynolds number of atmospheric air at 50 in. of water differential and can be used for most gases and vapors at ordinary pressures. Curves are also given showing the effect of edge thickness and bevel on coefficients, and recommendations are made as to plate and edge thickness and condition for orifices to which the coefficients would apply.

INDUSTRIAL AND UTILITY CO-OPERATION STRESSED AT

INDUSTRIAL POWER SESSION

Utility and industrial engineers frankly expressed their views on the interchange of power services between the industrial power plant and central station

ONLY two papers were presented at the Industrial Power Session. This allowed time for much interesting discussion. Both papers were somewhat related in subject, one dealing with interchange of steam and power between industrial plants and utility systems, the other with general aspects of industrial power plant design.

INTERCHANGING STEAM AND ELECTRIC POWER

IF THE utilities would accept the industrial plant as a possible source of heat-energy, and the industrial plants were to take advantage of recent technical developments, the present capacity installed in industrial plants would be by no means a measure of what might justifiably be installed. It is obvious that these new conditions would result in a large increase in industrial capacity, mostly available for generating surplus energy. With industrial capacity now 28 per cent of utility capacity, it is equally obvious that any large increase in industrial capacity is of such magnitude as to satisfy the nation's demand curve for some considerable future period, and leads to the conclusion by the author, H. D. Harkins, that the larger part of future electrical generating capacity should be installed in or near industrial plants, rather than in condensing steam or hydro central stations.

Public utility systems are generally interconnected in a few large regional power pools, giving them the advantage of emergency supply, diversity and reduction in equipment. Few industrial generating plants are so interconnected, either with each other or with the regional system. Many industrial plants generate electrical energy and utilize the exhaust from the turbine, thus producing electrical energy at much higher thermal efficiency (80 per cent) than can be obtained in utility stations (25 to 30 per cent).

Utility companies generally refuse energy from industrial plants and other co-operative schemes for the following reasons:

1. Possibility of having to face the charge of discrimination in cases where the utility chooses to make a working arrangement with one industrial, and to deny it to another.
2. Hazard to service presented by a number of small isolated plants whose engineering and operating standard may be below the utility grade.
3. Complications of supplying process steam and other non-electrical service to industrials.
4. Financial hazards and disagreement potential in joint ownership and operation of utility and industrial plant equipment.
5. Danger of increasing industrial business to an unsafe volume in proportion to total business.
6. Objections to committing utility funds to investment in power facilities in industrial plants of uncertain continuity.
7. Possibility that an industrial plant with excess capacity will attempt to sell this directly to users at a higher profit than the interchange rate permits.
8. Variations in the efficiency of industrial plants delivering by-product electricity as a function of blast or other process heat uses.
9. Inflexibility of such by-product power plants as compared with utility generating stations.

Much of the difficulty in reaching a co-operative agreement for the mutual sale or interchange of electric energy between utilities and industrial companies lies in the misunderstanding of the value of the unit of energy. The value varies widely if it be "firm or dump," with the time of the day and year, and with the installed capacity of each party at the instant of generation.

The power utility is given a monopoly on the assumption that it will serve the community more efficiently than any other means yet devised. Therefore, it is obligated to investigate sources and secure cheap energy either by purchase or generation, and to distribute energy cheaply and efficiently. It is not unreasonable to ask these companies to purchase surplus industrial energy, if such purchases will benefit the community by fostering local industries and reducing the utility cost. Certainly, this conception of the utility does not justify the intense and extravagant effort sometimes made to prevent industrial generation.

While co-operation between utilities and industrial plants has no existence on a national scale, there are isolated instances. The paper called attention to a considerable number of such relationships. Of the industrial plants cited in the paper as having co-operated in relations with the utility companies, fifteen were described in detail in the May 27, 1930, number of *Power*.

DISCUSSION

Intense interest was shown in the views and data presented in Mr. Harkins' paper. The only flaw in the proceedings, officially devoted to industrial power problems, was the fact that the group of excellent discussions presented by central station engineers left little time for comment from the industrial side of the house.

Most of those discussing Mr. Harkins' paper inclined to the opinion that the benefits of power exchange to the utility have been greatly over-rated, that difficulties are much greater than some think, and potential saving much less.

In a written discussion, James A. Powell, of Barstow Management Association, Inc., stated his approval of the idea of power exchange, but only within a very restricted field, and applied with great care. He urged that all special conditions be considered and that outside engineers be called into consultation. It is necessary, he said, to consider not only present conditions, but possible improvements in operation. Only large plants in stable industries, he said, should be considered.

Mutual profits, said James Muir, speaking for the utility group, must be the basis of exchange. He feared a hazard if many small industrial units were added to a system, and also felt that the average industrial plant has little or no surplus power available, and should, therefore, not be considered. The ideal situation, Mr. Muir pointed out, is an industrial with a very large steam demand and very small power demand. Such plants are rare.

Of particular interest was the discussion by K. M. Irwin, of Philadelphia. Mr. Irwin has been closely associated with the Deepwater (N. J.) Station, which utilizes exhaust evaporators to supply large quantities of process steam to a neighboring industrial plant. It is easy, said Mr. Irwin, to be over-optimistic about the gains to the utility from interchange. Only *firm* power is of appreciable value. Power that seems to be firm in a period of prosperity turns out to be otherwise during depression.

Surplus energy, he said, is worth to the utility something less than it would cost the utility to make it itself, less the transmission loss. He also warned against using up transmission and distribution capacity needed for the normal business.

After many elaborate studies of concrete cases, Mr. Irwin's company has found only two where a mutually profitable and safe solution has been worked out. One of these cases is the Deepwater arrangement. Installation of the other has been delayed by business conditions.

C. F. Hirshfield, chief, Research Department, Detroit Edison Co., could see little practical future for interconnection of utility and industrial plants. Interconnection has its field, he said, but not in the majority of cases.

Some of the greatest difficulties pointed out by Mr. Hirshfield are legal rather than technical. Supply of power to a utility may place upon the industrial itself some of the obligations that bind the public service corporation. The industrial may inadvertently incur an obligation to supply power when business conditions make this unprofitable.

Similar comments were made by E. D.

Dreyfus, consulting engineer. He said that industrial executives are prone (as in 1928) to misjudge the future. Large investments, based on wrong judgment, may mean business suicide. No amount of engineering knowledge can compensate for such errors. The utility, in turn, must avoid undue risk.

Vern Alden, of Stone & Webster, discussed Mr. Harkins' paper with a background of five years largely devoted to a special study of industrial and utility power problems. In general, he said, the utility cannot consider buying power from an industrial having a steam load less than 100,000 lb. per hr. Mr. Alden was, however, more favorable to interchange than some of the other speakers. He said that utilities must learn to think in terms of small blocks of power, namely, 2,000 to 5,000 kw. He also suggested that utilities maintain a potential capacity shortage to leave room for an acceptance of industrially produced power.

STEAM AND POWER SUPPLY

GENERAL FACTORS to be considered in planning steam and power projects for industrial plants were presented by V. E. Alden at the Industrial Power Session.

Few factors are so important in preliminary design of an industrial power plant as a reasonably accurate estimate of the loads to be carried during the effective life of the project. Such an estimate depends upon the particular industry and the stability of the underlying enterprise will determine the use and the life of an industrial power plant.

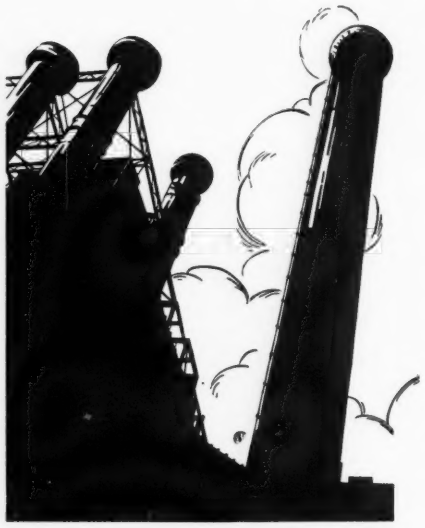
Flexibility is important, and for rapidly growing industries, operating conditions which will probably be existent several years in the future should be given due weight in making today's decisions as to characteristics of equipment.

Fixed charges constitute so large a part of the over-all cost of steam and power that it is seldom possible to justify the installation of new equipment to work on the same cycle and replace existing but somewhat less efficient equipment. Modification of the basis cycle through provision for generation of electric load as a by-product of the steam load reverses the picture. Some industries are served by many small low-pressure boilers, which, because of age and deterioration, should be abandoned. Such a condition strengthens the justification for installation of efficient fuel-burning equipment, and high-pressure equipment, which will permit generating by-product power.

A power plant generating large amounts of process steam and by-product power operates at an efficiency and produces steam and power for over-all costs which cannot be approached in even the most efficient condensing station.

There is a trend in industrial power plants to use fewer and larger boilers and turbines. This trend emphasizes the importance of reserve capacity. Inspection and overhaul of turbine generators is necesary at least every two years. Possible sudden and unforeseen outages have not been entirely eliminated. An industrial steam and power supply project which neglects these facts is fundamentally unsound.

Attractive possibilities are presented by the use of a single power-plant to serve several industries. The obvious advantages are: Pooling of reserve capacity, possible use of larger boilers and turbines, and the thinner spreading of the overhead costs. The most outstanding advantage, however, is that the investment for capacity in such a plant assumes less the aspect of a frozen asset and more the character of a negotiable security. No large investment should be made in such a power plant, unless the industries are of a stable type.



Far too little consideration has been given to the supply of steam to the industries from the large utility stations operating mainly on a condensing cycle. A major consideration in the location of any new generating station should be its ability to supply steam to industries.

ALDEN'S PAPER WINS HIGH PRAISE

Practically all of those who discussed Mr. Alden's paper praised it as a remarkable analysis of the problem of planning the steam and power supply of industrial plants.

Kerr Atkinson, of Boston, said that many industrials have postponed power investments because of the depression, and that they will soon, in the normal course of events, construct additional plants. This, then, is a crucial time for the utilities. If they fail now to establish group plants to supply both power and steam to industrials, they will lose for an indefinite period a strong competitive position.

The November number of *Power* contained an article by F. L. Bradley, of the Forstmann Woolen Co., Passaic, N. J., now operating two very modern steam power plants. That at Clifton, N. J., was described in the November number of *Power*. These plants generate both power and process steam. Because of differences in steam-power demand ratios, one plant was built for 250 lb. pressure and the other for 450 lb. The short period of operation to date has demonstrated clearly that predicted savings are actually being obtained. Yet at no point has reliability been sacrificed for efficiency.

Illustrating the inertia of industrial executives as far as power problems are concerned, Theodore Mainz, of Cleveland, cited a case where an industrial was advised, in 1928, that a new turbine would save its cost in a single year. To date the turbine has not been installed.

An entirely new slant on the problem of making or purchasing power was given by Mr. German, plant engineer, Scoville Manufacturing Co. Whose advice, he asked, shall the management take? Both the utility and the plant engineer are interested parties. No one is left but the consulting engineer.

Management, said Mr. German, has been slow to engage the consultant, because his survey is generally elaborate, and his fee correspondingly large. Yet, in many cases a casual study will show clearly that it will pay to make or to buy. Why not, then, engage the engineer to make first a brief preliminary survey so that large sums will not be spent on unnecessary studies.

Speaking of interchange, Guy Randall made the radical suggestion, that the utility put additional wires on its poles, to be used by one industrial plant desiring to deliver power to another. His argument, in brief, was that the law does not give the utility a monopoly of the privilege of *selling power,* but merely a monopoly of the privilege of *utilizing highways* for poles and other distribution equipment. Mr. Randall said the day will come when power from all power sources will be thrown together in one big pool.

Referring to the very extensive power interchange system in Belgium, George Orrok, consulting engineer, said that the average saving to those participating is about one-half mil per kilowatt-hour. All subscribers, he reported, are well satisfied. Steam plants below 1,500-kw. are not included in the exchange relationship. The government has no members on the governing committee.

PLANT ENGINEERS HOLD LUNCHEON

For several years, a substantial group of industrial plant engineers has held a private luncheon meeting at the time of the Annual A.S.M.E. meeting. This year, as before, this Industrial Power Conference Group luncheon was held at the Fraternities Club Building. More than fifty plant engineers, including many representing very large industrial establishments, were present. Wm. A. Shoudy, chairman, presided.

While held at the time of the A.S.M.E. Annual Meeting, and always after the official industrial-power session, the Conference Group maintains a separate identity and an informal organization which allows greater freedom of expression.

As chairman of the Plant Betterment Committee, David Moffatt Myers, consulting engineer, presented and secured adoption of a check sheet listing a large number of places where plant improvements might be made. It was felt by many that this sheet will be very helpful as a reminder.

One formal paper was presented, "Power and Heat Cost Analysis for Industrial Plants" by Louis Offer, a power and heating cost consultant of Highland Park, Mich. Professor Offer's paper stressed the importance of setting up a "par" for each power service cost, this "par" to vary with such factors as factory activity and outside temperature.

Alfred Vaksdal, plant engineer, Corning Glass, and Philip W. Swain, managing editor of *Power,* presented the report of the Power Cost Sub-Committee and tentative suggestions for a radically simplified cost system.

THERMAL ENGINEERING PROMINENT IN SESSION ON

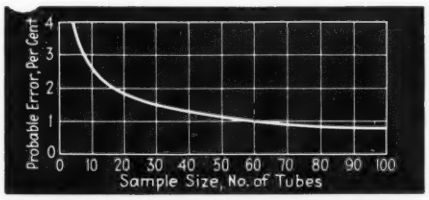
HEAT TRANSFER

THERMAL engineering was given a more prominent place in the program than usual, and two sessions were devoted to the subject of heat transfer. In the first session, the papers were of somewhat greater interest to oil refinery practice except two papers of interest of power plant engineers, one, "The Accuracy of the Cleanliness-Factor for Surface Condensers," and the other, "Application of Fouling Factors in the Design of Heat Exchangers."

ACCURACY OF CLEANLINESS-FACTOR

IN 1932, P. H. Hardie and W. S. Cooper presented before the Metropolitan Section of the A.S.M.E. a method which has been developed at Brooklyn Edison Co. for determining the cleanliness-factor of condensers prior to acceptance tests. Briefly, the method consists in installing several new tubes in representative positions in the condenser, isolating these new tubes and certain adjacent old ones by means of rubber-hose jumpers and comparing the performance of the new and old tubes in terms of heat transmittance.

Following the development of this method, some discussion has resulted as to the proper number of sampling tubes required to show a representative cleanliness factor for the entire condenser. Consequently, an investigation has been carried on to ascertain the probable accuracy of



Effect of sample size on accuracy

the cleanliness-factor measurement when determined from 24 isolated sample tubes. An effort has also been made to determine the quantitative effect of tube fouling on condenser performance. In this investigation, the cleanliness factor, as determined from 18 old tubes and 6 new tubes, was compared with the factor as determined from a total of 96 test tubes. The data so collected permitted the plotting of probable error against the number of sampling tubes. This showed that for 24 tubes the probable error was 1.6 per cent, or a corresponding accuracy of 98.4 per cent. More than 24 test tubes would hardly be justifiable because of the diminishing returns afforded by increasing the sample size. Even with 96 tubes the accuracy is improved only 0.8 per cent, or the accuracy is 99.2 per cent instead of 98.4.

The manufacturers, in their guarantees for cleanliness factors less than unity, have generally assumed that the over-all heat transmittance is reduced by fouling in direct proportion to the cleanliness factor. These tests, together with two previous tests on the same unit at higher cleanliness factors, have shown that this relation is not strictly true.

FOULING FACTORS IN HEAT-EXCHANGER DESIGN

DESIGNERS and users of heat-transfer equipment appreciate the fact that the full effectiveness of such equipment can only be realized when the transfer surface is in a clean condition. When a set performance must be maintained over a reasonable period, additional surface must be provided over that theoretically required. The usual way to apply a factor of safety is in the form of extra surface expressed as a percent of the theoretical or clean surface required. E. M. Sieder in "Application of Fouling Factors in the Design of Heat Exchangers," maintains that this method is faulty and does not give a true picture of the allowance made for dirt. He suggests that the logical way to provide a factor of safety in heat exchanger design is to add a resistance factor to the reciprocal of the clean or over-all heat-transfer coefficient. The equation thus becomes $\frac{1}{u_d} = \frac{1}{u_c} + r_d$ where U_d is equal to the over-all heat-transfer rate with tubes in a dirty condition, U_c is the theoretical or clean tube over-all heat-transfer rate, and r_d is the dirtiness factor for the dirt on the inside and the outside of the tube.

The paper includes a number of curves showing dirtiness factors experienced in various oil-refinery equipments.

DISCUSSION

In discussing the paper on accuracy of condenser cleanliness-factor, J. F. Grace pointed out that the cleanliness factor of the entrance group of tubes was less than the average and the factors for the exit group of tubes was higher than the average. Because the entrance tubes do more work than the exit tubes, he suggested that the cleanliness factor for the entire condenser be determined by a weighted average on the basis of tube loadings.

E. L. Lindseth inquired as to the effect of cooling-water velocity on cleanliness factor, to which Mr. Hardie replied that the influence of velocity was shown in a previous paper and that it was necessary either to determine the factor at the velocity to be used in the condenser tests or to make two determinations at different velocities.

Prof. H. Diederichs told of heat-transfer work at Cornell University, where it was found that under atmospheric pressure conditions, the heat transfer of a dirty tube was found to be about 500 B.t.u. per deg. per sq.ft. per hr. When cleaned on the inside, the transfer rate increased to 700 B.t.u and when cleaned on the outside the transfer rate jumped to 1,600 B.t.u. Upon investigation of the reason for the latter large increase, it was found that with the tube dirty on the outside, condensation formed a film on the tube surface, but when the tube was in a commercially clean condition, condensation formed drops on the tube surface. This condition was illustrated by moving pictures and was said to be insensitive to tube loading but quite sensitive to tube cleanliness.

S. A. Tucker expressed the belief that at normal condenser vacuums, the effect of cleaning the outside of the tubes would not be as great as indicated by Prof. Diederichs.

HEAT TRANSFER IN AIR HEATER AND ECONOMIZER

HENRY KREISINGER in a paper on heat transfer in air heater and economizers first outlined the process by which heat is transferred from the gas to the air or water. He then pointed out that acceptance tests are usually made after the apparatus has been in service for some time and a layer of soot and ash has been deposited on the gas side of the metal plate. Inasmuch as the layer may be of varying thickness and density in different installations, the rate of heat transfer varies appreciably and makes close prediction of the efficiency difficult.

In the calculation of the performance of air heaters, the rate of heat transfer is taken to vary with the weight of gas and air per square foot of cross-section, called the mass flow, and is adjusted to the probable cleanliness of the heating surfaces. Such adjustment can be made intelligently only from test results.

A simple equation useful in determining the heat transfer in air heaters is:

$$H = (A + BW)\ (T - t)\ S$$

where H equals the quantity of heat transferred per hour, A and B are constant determined from test results, W equals average weight of gas and air per square foot of cross-sectional area per hour, T equals mean temperature of gases, t equals mean temperature of air, S equals effective heating surface in square feet. The average value of A is 0.4 and that of B is 0.00045.

In an economizer, the weight of water passing over the heating surfaces and the heat-absorbing capacity of the water is large so that the water takes up readily the heat transferred to the metal wall by the hot gases. The temperature of the heating surface is close to the temperature of the water. Therefore, the heat transfer by convection from the gases to the metal determines the rate of heat transfer and the calculation of the performance is simplified. In the preceding general equation, W is the weight of gases per square foot of cross-section of the gas passage, T is the mean temperature of gases, and t the mean temperature of

water. The averages of constants A and B are 2.2 and 0.00095, respectively.

DISCUSSION

W. A. Evans asked whether information was available concerning heat transfer with corrugated sheets for air preheaters. C. E. Creutz answered that corrugations increased heat-transfer coefficients as much as 100 per cent in some cases. W. J. King stated that turbulence increases heat transfer, but usually costs too much to produce when velocities are high. With low velocity it is more profitable.

To questions concerning condensation in air preheaters the author replied that this often occurred, particularly at the air entrance to the preheater, also when the fuel had a high hydrogen content, often with lignite.

HEAT TRANSFER IN MERCURY SYSTEMS

WITH increased use of mercury as a heat-transfer medium, it becomes important to know more about the process of heat transfer to it. W. T. Moore pointed out that liquid mercury at atmospheric temperature does not wet the steel surfaces with which it is in contact, whereas one ordinarily thinks of heat transfer in terms of water which wets the metallic surface that it contacts. It is conceivable that mercury may wet steel tubes under certain conditions, although convincing proof is not yet available.

When the liquid wets the surface with which it is in contact, heat flows readily from the metal surface into the liquid of the film. Vapor bubbles formed break away and are replaced by more liquid. With mercury which does not wet the surface, there is less positive contact between the metal and liquid and less tendency for the vapor bubbles to break away from the surface and be replaced by the liquid. Hence the supply of liquid in contact with the metal surface is not easily maintained.

Another complication in the case of mercury is the fact that temperatures in the lower parts of the apparatus may be considerably higher than temperatures at the surface of the liquid, due to the high density and low specific heat of liquid mercury.

Mercury boilers have been operated

(Continued on Page 725)

PROBLEMS ENCOUNTERED IN BURNING PULVERIZED COAL

TWO PAPERS presented at the Fuel Session had to do entirely with problems encountered in burning pulverized coal, and were of interest and value to both operators and designers of pulverized coal equipment.

BURNING CHARACTERISTICS OF PULVERIZED COAL

THE result of an experimental investigation to determine the relation of the rate of burning of pulverized fuel, and of the radiation from the flames to the type of coal, and its fineness of pulverization were presented by Ralph A. Sherman. The furnace in which these tests were carried out was a horizontal refractory lined, steel-shell, 3½ ft. inside diameter and 14 ft. long. The burner had a venturi throat to promote mixing of coal and air and an inner cone that made a ring through which the coal and air entered the furnace; all the air used for combustion was introduced as primary air.

It was found that the rate of decrease of unburned carbon with increase of excess air was not the same for different coals. The unburned carbon continued to decrease up to 30 per cent excess air with Pocohontas coal, whereas there was little decrease beyond 20 per cent excess air with Hocking coal.

The fineness of grinding becomes increasingly important as the combustion space is restricted, and the optimum limits of fineness, without regard for power consumption in these experiments, differed with the type of coal.

Although the Pocohontas coal, 18 per cent volatile content on moisture-and-ash-free basis, was the slowest-burning of the four coals, Illinois coal, volatile content 42 per cent, burned more slowly, and Pittsburgh coal, volatile content 44 per cent, burned only slightly more rapidly than Hocking coal, the volatile content of which was 40 per cent.

No distinction could be made in these experiments between the total time of combustion and the time from ignition of the coal, as the difference in the rate of combustion with different coals and furnace temperatures was particularly marked in the early part of the combustion; the ignition temperature of the coal and the temperature of the ignition are indicated as important factors in the over-all combustion process.

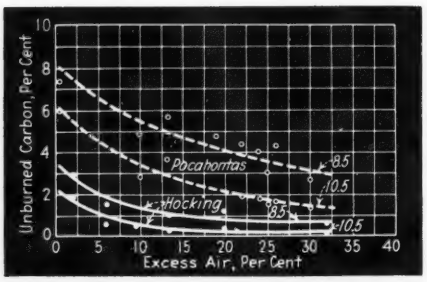
Although temperature and radiation from flames were effected by the fineness of grinding, excess air, and rate of firing, the emissivity of the flame at any one position was affected to a marked degree only by the type of coal.

The radiation from the suspended carbon and ash particles is an important part of the total radiation as the emissivity of non-luminous gas flame in this furnace was about 0.2, whereas those of the pulverized-coal flames were 0.7 to 0.3, decreasing as the carbon burned from the flame.

DISCUSSION

Discussion of Mr. Sherman's paper brought out many views regarding the radiation from the flames of pulverized coal. Several speakers questioned the validity of the conclusions drawn by Mr. Sherman.

R. M. Hardgrove, of the Babcock & Wilcox Co., suggested repeating the experiments with a better burner. He said it should be possible, in a furnace of this



size, to get a heat release of 75,000 B.t.u. per cu.ft. per hr., instead of 20,000. He felt that the apparatus and methods used for measuring radiation in temperature were subject to considerable errors.

SLAGS FROM SLAG-TAP FURNACES AND THEIR PROPERTIES

THE report of the Special Research Committee on Removal of Ash and Molten Slag from Powdered Coal Furnaces was presented by P. Nicholls. In general, the flow temperature of slag decreases with increase in reduction of iron in the slag; that is, increase in the ratio of FeO to the total iron. Also, the effectiveness of a high ratio increases as the total iron in the slag increases. Seventeen plants cooperated with the committee by sending in samples. Usually these were taken from special runs during which samples of the coal, slag and, if possible, fly ash, were collected. Fuels tested included lignite, bituminous and semi-bituminous coals, and petroleum coke, the flow temperatures of the slag ranging from 1,975 to 2,700 deg. F.

Reduction of iron in the slags was high, usually to about 90 per cent ferrous iron. There were indications that in a given plant the reduction increased with the rate of burning, but there was no general relation between reduction and rate of burning independent of other factors.

Metallic iron in the slags was usually under 5 per cent of the total iron. There was no metallic iron in any fly ash when analyzed, but there is the possibility that some may have been present when the ash left the furnace, but that it was oxidized or converted to sulphate. Combustible in the fly ash was about 6 per cent for samples collected from the air stream; that in the grab samples was high.

The possibility of returning fly ash to the furnace and absorbing it in the slag was reported as being attractive. The general feasibility of such a procedure depends on the quantity of fly ash, the relative fusibilities of fly ash and slag, and the flow temperature of the mixture. A limited investigation was made to determine what factors were involved in the absorption of the fly ash by the slag.

In this connection it was found that wetting the ash prevents the ash from being carried out of the furnace again. The addition of moisture materially assisted the local distribution of the ash. The combustible in the fly ash has two important effects. (a) Even with 5 per cent combustible in the interior of the lump of ash, iron was highly reduced, 60 per cent of the total ash being metallic iron; (b) the carbon acted as an infusible diluent, which retarded the melting of the ash; this effect increased with the percentage of combustible.

Discussion

Discussion of the paper presented by Mr. Nichols and Mr. Reid revealed wide interest in the subject of slap-tap furnaces, and the general feeling that the information gathered by the authors will be very useful. On technical points, however, some differences of opinion appeared.

A speaker from Pennsylvania State College compared furnace slag to glass. He pointed out that the viscosity of molten glass varies with time as well as temperature, and that slag should vary likewise. He questioned the possibility of judging slag fluidity on the basis of the "ferric percentage" alone.

The practicability of capturing fly ash by directing it back to the molten slag pool was discussed by John J. Grob, engineer of tests, United Electric Light & Power Co., New York. His comments were based on experience with the Hell Gate Station. Recirculation, he said, will capture only a portion of the fly ash. Slag-tap operation, said Mr. Grob, has many advantages over the dry-bottom furnace, greatly reducing outage and the burden on cinder catchers. It also permits higher CO_2, and therefore higher boiler efficiency. Moreover, the pool of hot slag tends to stabilize combustion conditions.

About 80 large slag-tap furnaces are now in operation, according to E. G. Bailey, of the Babcock & Wilcox Co., who stated that about 75 per cent of the coal available for utility use has an ash melting temperature under 2,500 deg., and is therefore suitable for slag-tap operation. Slag-tap furnaces permit high efficiency with a wider range of fuels than is possible with any other method of burning. One limitation, he pointed out, is the difficulty of handling high-fusion coals when operating continuously at low ratings.

In his closure, Mr. Nichols expressed great interest in the Hell-Gate experiment of wetting fly ash with salt water before recirculating over the slag pool. He said that the salts would increase the fluidity of the ash, but did not know whether it would have a bad effect on furnace refractories.

Hudson Avenue Stokers Meet Guarantee

Wide interest was shown in the announcement, made by G. L. Knight, vice-president of the Brooklyn Edison Co., that the large stokers installed about a year ago at the Hudson Avenue Station, had fully met their capacity guarantees. These stokers and all of the additions to the station were described in the May 31, 1932, number of *Power*.

"These stokers," said Mr. Knight, "from the very first have been able to carry the loads required of Nos. 7 and 8 boilers. While the exact top rating of the stokers as installed is debatable, it can be said to be somewhere between 350,000 and 400,000 lb. of steam per hr. The eight stokers, as installed, have given very good day-to-day efficiency in the operating range imposed on them." He reported stoker maintenance (including grates and ashpits) around six cents per ton of coal, based on 800,000 tons of coal burned in 22 months. There has been no maintenance to date on the gear box and Hele-Shaw drive units.

For a good many months, Mr. Knight pointed out, No. 74 stoker had been devoted to the manufacturer's experimental work in the interest of meeting the capacity and efficiency guarantees. It has been equipped with manually-operated zoned air control employing 69 venturi throat sections under the tuyeres and extension grates to control and measure the air flow to the grates.

As evidence of the beneficial effect of this zoning, Mr. Knight referred to numerous high-output runs of five- or six-hour duration at 530,000 lb. of steam per hour output, equalling the two-hour maximum capacity guarantee given on the equipment. This corresponds to a coal-burning rate of approximately 85 lb. per sq.ft. of grate area. Nov. 16 an output in excess of 630,000 lb. per hr., was carried for over three hours, and an output above 610,000 lb. for five hours. The output was finally lowered because of station load, not because of the stoker. Several 24-hour or longer runs have been made at an output of 450,000 lb. per hr., 452,000 lb. being the maximum continuous output guarantee. "It can be said without qualification," said Mr. Knight, "that with zoned air control, the capacity guarantees of the stokers will be exceeded."

Official efficiency tests have not yet been made. No. 72 stoker is now being modified to duplicate No. 74, except for the air control. By comparing the two the importance of air control will be evaluated. "We take pleasure in saying that the quality of workmanship and materials in these stokers has been of the highest," said Mr. Knight in conclusion.

EXHAUST PIPE LENGTH, HUMPHREY PUMP, TOPICS AT

OIL & GAS POWER SESSION

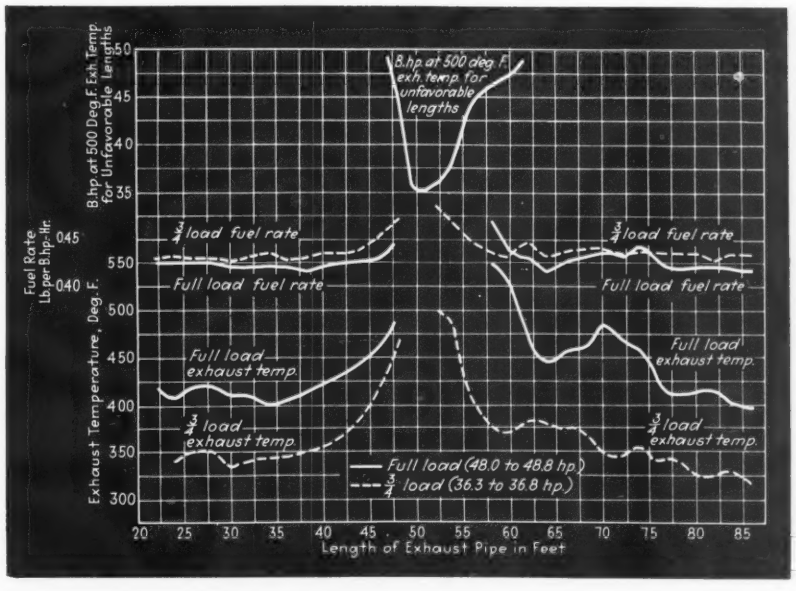
When diesels first came into prominence, they were designed and considered independently of their auxiliaries. With present refinements of design, however, more and more effort is being made to obtain maximum efficiency from each installation. Selection of a proper exhaust-pipe length obviously assists, since pulsation of the exhaust, particularly in 2-cycle units, may set up a resonant condition, with new exhaust impulses coming on top of reflected pressure waves, thus increasing back pressure and cutting scavenging and intake efficiency.

EXHAUST PIPE LENGTH

Kyle C. Whitefield reported a series of tests on a 1-cyl., 50-hp., 2-cycle diesel running at 362 r.p.m. Standard engine-performance tests apparatus was used, load being applied by prony brake. A balanced-diaphragm type indicator proved more accurate than a standard Crosby unit. Pressure elements with the former were installed at 8½ in., 10 ft. 3 in. (just before straight-through type muffler) and 17 ft. 7 in. from the engine exhaust port along the exhaust pipe. Performance tests were made at successive decrements of 2 ft. from the original pipe length of 86 ft. at full and three-quarter load, with low-pressure diagrams at each step. Judging from the full-load rates shown in the diagram, most favorable lengths of exhaust pipe for this engine were 38, 64 and 86 ft. However, exhaust temperature was higher at 64 ft., hence for continuous operation the other two would be better.

Velocity of the exhaust was calculated

Fuel rates and exhaust temperatures with various exhaust pipe lengths


B.hp. at 500 Deg.F. Exh. Temp. for Unfavorable Lengths
B.hp. at 500 deg. F. exh. temp. for unfavorable lengths
Fuel Rate Lb. per B.hp.-Hr.
Exhaust Temperature, Deg. F.
¾ load fuel rate
Full load fuel rate
Full load exhaust temp.
¾ load exhaust temp.
Full load (48.0 to 48.8 hp.)
¾ load (36.3 to 36.8 hp.)
Length of Exhaust Pipe in Feet

as 1380 ft. per sec., practically the same as the velocity of sound in the exhaust gas at the exhaust temperature, according to the formula $V = 49\sqrt{T}$, where T is the absolute temperature of the gas.

This aids in the determination that the second reflection of the exhaust-pressure impulse from the open end of the pipe interferes with scavenging in the unfavorable performance ranges. A 58-ft. exhaust pipe is particularly bad.

Discussion

In discussion, J. Sweetser of the University of Maine pointed out that in some similar tests with gasoline engines, he had determined that favorable exhaust pipe lengths were multiples of 8 ft., which corresponds roughly with Mr. Whitefield's figures. Similar tests by Westinghouse engineers on a 1,000-r.p.m. 4-cycle, 1-cyl. unit showed the same result and have led them to figure exhaust-pipe lengths on a basis of any even number of pressure waves plus one-quarter wave, so that the new exhaust impulse strikes the port end of the exhaust as the pressure in the pipe outside the port is decreasing, thus favoring scavenging. By using this system, a fuel consumption of 0.515 lb. per b.hp.hr. was bettered to 0.436.

Mr. Rukka, explaining similar foreign tests, said that on a 36-hp. engine without exhaust pipe, the horsepower rating was stepped up to 39 by adding a 6-ft. exhaust pipe with a cone nozzle end. These results have led to adoption of this type of exhaust on racing cars. Mr. Nordlinger of Penn State pointed out that his studies lead him to believe that figures determined for diesel engines are also applicable to other internal combustion engines and also to steam engines.

HUMPHREY GAS PUMP

Some years ago, the Humphrey gas pump for pumping water by displacement was expected to offer remarkable economies. It will be remembered that this pump operates with the expanding gases working directly against the water column, no piston being used. The World War hampered immediate development of the pump, so that comparatively few installations have been made. F. DuP. Thomson, consulting engineer for Sun Shipbuilding & Drydock Co., American licensee, described the present status of the pump and showed a newer 2-cycle design (right) that is much simplified.

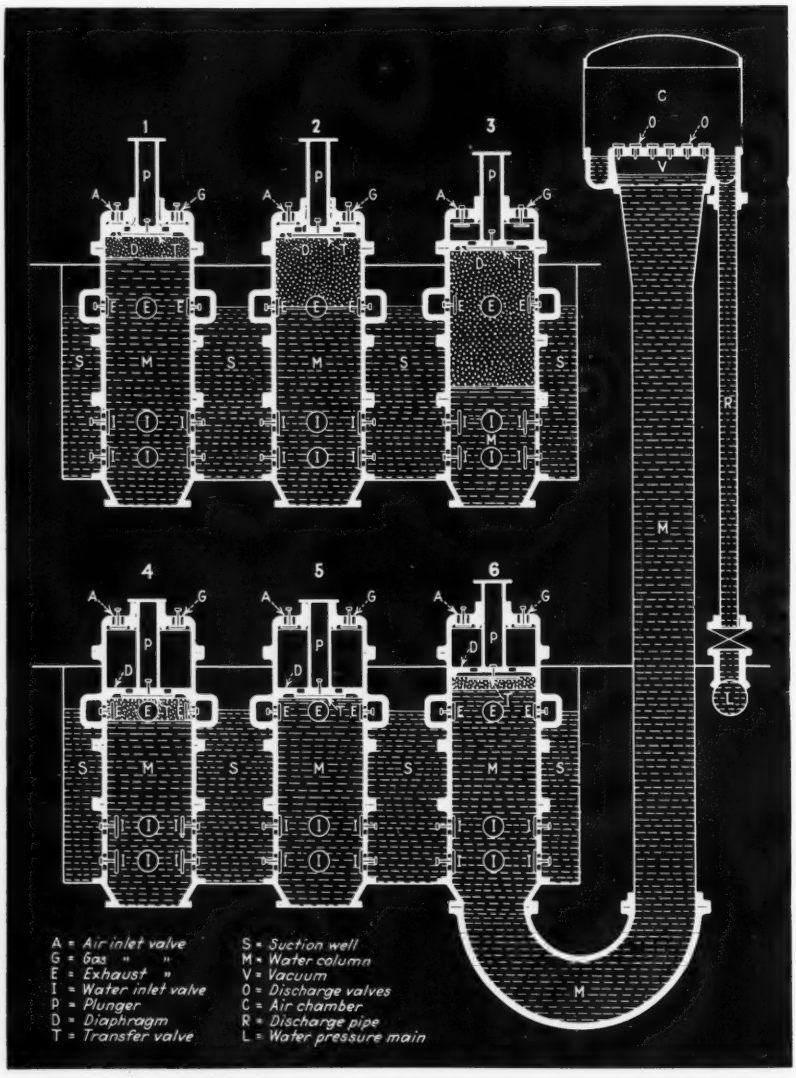
At the present time, there are three working installations, the largest at Chingford, near London, which has been working since March, 1913. It uses five large pumps with combined capacity of 250,000,000 gal. daily against 30-ft. head. Acceptance tests gave consumption of anthracite coal (for producer gas) per actual water hp.-hr. ranging between 0.80 and 0.95 lb.

The second installation is at Cobdogla, South Australia, on the River Murray. Two pumps, each with capacity of 28,000 g.p.m. against 27.5-ft. head, have been operating since May, 1930, tests showing consumption of 4.15 lb. of air-dried Mallee wood (for producer gas) per water hp.-hr. Both stations have 4-cycle pumps.

Sun Shipbuilding, after considerable development, installed a 36-in. service-test unit of the 2-cycle Steckel-Humphrey type diagrammed on this page. Simplicity of equipment of the station, as well as efficiency of the pump itself, have been sacrificed to some extent to secure great flexibility in range of head and provision for using the water pumped in a hydraulic air compressor. Caisson-type construction was adopted, which was most fortunate in that elbows and U bends were eliminated entirely from the play pipe and a straight length of pipe extending down into the caisson substituted, discharging into the bottom of this well under the required pressure of air in the chamber below the sump.

This station has been operated at heads from 20 to 120 ft., supplying at one time 2,000 g.p.m. 24 hr. per day for two weeks, at 120-ft. head, and running 7 hr. daily for the remainder of the 2-year test period. The 2-cycle unit increases capacity 66 per cent and is less sensitive to variations of sump level or changes in tension of valve springs, either of which affect pump efficiency seriously.

No auxiliary pumps are used for scavenging and charging. A diaphragm is interposed instead between the fresh charge and the exhaust gases. This is a light-plate piston fitting loosely in the combustion chamber (may have as high as $\frac{1}{32}$ in. clearance). A novel form of intensifier has been added which makes it practical to pump against heads of 120 ft. with material increase in speed and consequent total horsepower for a given capital outlay.



Six positions of the cycle are shown. The water column of Fig. 6 has been left off the other drawings purely for conciseness. In Fig. 1, the charge is ready for firing. It is fired by spark plugs (not shown) just below the upper flange. Upon firing, the gases expand, Fig. 2, overcoming the inertia of the water column *W* and beginning discharge at *O* (extreme upper right). Expansion does not stop at this point, however, but, due to the momentum of the water column, continues as in Fig. 3 until the gas pressure is atmospheric and the water level is depressed almost to the level of inlet valves *I*. When the pressure of the gas drops below $4\frac{1}{2}$ lb. the diaphragm *D* moves downward of its own weight, drawing in the new charge of air and gas through valves *A* and *G*, Fig. 4. Exhaust valves *E*, previously held shut by pressure, now spring open and exhaust begins. By this time, the momentum of the water column has been lost and it is ready to begin swinging back, but check valves *O* limit this action. Consequently, water from the sump rushes in at inlet valves *I*, Fig. 4, forcing the exhaust gases out, then closing the exhaust valves, Fig. 5. Air and gas inlet valves also spring shut. The momentum of this entering water, reinforced by that of the water column, carries it in turn beyond the sump water level, forcing diaphragm *D* back up and compressing the gases above it. The momentum of the diaphragm carries it to the cylinder head, while the increasing pressure of the gases causes them to open transfer valve *T* and pass below *D*. The force of the rising water column is great enough to provide the desired compression and also to push the diaphragm up so rapidly that a dashpot must be used above it to arrest the last foot of stroke.

The charge is now compressed beneath the diaphragm, with transfer valve *T* closed, and the cycle is complete.

Pumps to work against heads between 30 and 60 ft. require no discharge valves, because the m.e.p. is more than sufficient to maintain discharge during the entire expansion stroke. A set of check valves is, however, necessary in the column, which while permitting free flow on the power stroke, throttles the flow on the back stroke to that head which will give the desired compression. Pumps for heads less than 30 ft. need have no obstructions whatever in the water column. All valves used are of simple type. A single control valve for the air-gas mixture avoids minute individual adjustment of valve springs and also insures against backfires by cutting off the gas supply completely before the end of the charging stroke and scavenging the gas ports ahead of the admission valves with pure air. This air, on the succeeding compression stroke, is first to enter the top of the combustion chamber and extinguishes any lingering flame.

The tubular type water valve now used is more efficient in inlet capacity for the space occupied than any conventional unit investigated. Without resorting to excessive inlet-valve area, this valve allows the pump to be readily filled to the level of the exhaust valves (at the level of the sump), before the water column commences to return for the compression stroke. Delay in filling would involve a slip-back of a portion of the water pumped on the power stroke and consequent loss of efficiency. The same valve, set horizontally and provided with holes on the underside to permit air within the tube to act as a cushion, is used as a discharge valve in the high-head pump.

Ignition apparatus is a simple Lodge unit using Leyden jars, providing a high-intensity, high-frequency spark to ordinary automobile spark plugs. The number of plugs depends upon the size of the cylinder. They are placed at the upper flange.

The Humphrey cycle is some 10 per cent more efficient than the Otto cycle, allowing for the unavoidable losses between the usual gas engine and the delivery of water by the pump it drives.

Extension in distribution of natural gas has opened a wide field for this pump, not only for municipal water supply and industrial water supply, but for production of peak-load power in conection with pumped-storage projects which its low cost makes possible. A suggested design for this service uses eight pumps with 10-ft. diameter cylinders to produce 30,000 kw.

Discussion

In discussion it was brought out that the pump does not contaminate the water, since the water surface exposed to the gas never changes, but simply moves up and down as would a piston. Mr. Trump mentioned several installations planned for irrigation in the West, one installed in California pumping at 70-ft. head at 260 cycles per min. This unit, however, had a piston. Since speed is a function of head, the usual Humphrey unit is too slow to be generally practicable for irrigation work. (The frequency of the Chester unit is, for example, 15 cycles against a 30-ft. head.) The frequency depends upon length of play pipe and head, increasing as they increase. If frequency is too high, too much energy is used up in friction. Against a 30-ft. head, this unit discharges 32 ft. of the 90-ft. column of water on each stroke—which emphasizes the need for suitable inlet valves in order to get new water in the play pipe before the column changes direction.

Mr. Thomson said that 4½ lb. will balance the diaphragm, compression pressure is about 30 lb. and highest pressure at combustion about 140 lb. The greatest temperature rise is about 60 deg. at the plug just below the top flange. Discharge of the pump is about 8 to 10 times the depth of the gas charge.

AIR CONDITIONING

For the first time at an annual meeting, a complete session was devoted to the subject of air conditioning. The program was under joint auspices of the American Society of Refrigerating Engineers and the Process Industries Committee of the A.S.M.E. Three papers were presented, covering psychometric investigations, the physiological side of air conditioning, and noise elimination.

ERRORS IN PSYCHOMETRIC DATA

The great importance of psychometric data to the air conditioning of buildings and factories has led to a close scrutiny of the fundamental data pertaining to the properties of air and water vapor mixtures. The author states that the air-conditioning industry has developed to such a point that every effort should be made to make certain that the psychometric tables are exact to at least one-tenth per cent.

The wet bulb thermometer which is used to determine the moisture content of the air has the advantage of great apparent simplicity, but, in common with most simple devices, in this case the interplay of effects of heat conduction, radiation, vapor concentration, rapidity of air circulation, combine differently under varied conditions in a manner to make interpretation of the readings as a function of air-vapor content extremely complex.

In relating the readings of the wet-bulb thermometer to the air moisture content, it must be assumed that air-vapor mixtures are governed by the laws applicable to ideal gases. It can be shown, from the data of Pollitzer & Strebel, for air-water mixtures, that the amount of water vapor in the air at ordinary temperatures and pressures, at the saturation state, is, as a minimum, 0.3 per cent greater than computed by the ideal gas laws.

The author points out that when a neutral gas exists to contact with a liquid it can be shown that the normal vapor pressure of the liquid will be increased. This correction can be made with precision, and is in the order of 0.08 per cent. The combined effect of the ideal gas laws defects on the vapor-pressure rise, due to pressure, is additive and probably amounts to between 0.4 and 0.5 per cent in increasing the water-vapor contained in a unit of air.

The author concludes that two steps are required before a definite psychometric table can be prepared. First, the wet-bulb thermometer should be developed to a point where it is radiation shielded and generally reduced to a design which will give reproducible readings to 0.01 deg. C. Second, given a really sensitive and reliable wet-bulb instrument, the actual analysis of air as a function of the wet-bulb indications should be carried out at different temperatures, using test air of varying moisture content.

Discussion

A. A. Adler pointed out in the discussion that the trouble was not so much in the application of perfect gas laws to air-water mixtures, as it was that the perfect gas laws are wrong in that they assume a straight-line relation at the extreme low temperatures and that the molecule has no mass. He pointed out that there were two methods of expressing relative humidity, and that there should be some agreement reached as to which of these methods should be used.

It was also pointed out that the absence of accurate data at the low temperatures used in room freezer work resulted in errors of 10 to 20 per cent.

PHYSIOLOGICAL SIDE

Dr. R. R. Sayres, in discussing the physiological side of air conditioning, pointed out that in industrial applications it was not always necessary to control simultaneously temperature, humidity and air movement as required under the definition of air conditioning. Comfort and physiological effects, he said, correlated satisfactorily. Satisfactory relative humidities are obtained between 47 and 70 per cent, and 67 per cent relative humidity was given as an optimism condition.

Carbon monoxide first becomes noticeable when its concentration reaches 3 per cent. Under 5 per cent concentration, breathing becomes labored, and at 8 per cent concentration carbon monoxide is extremely distressing. Methane and ethane gases are not toxic, and one suffers only from the lack of oxygen. Hydrogen sulphide, on the other hand, has about the same toxicity as carbon monoxide.

Ionization has been found to produce certain physiological effects, though enough work on this has not yet been done to permit definite recommendations. It is, however, known that there is a difference between the effect of positive and negative ionization, and that negative ionization produces a restful condition. It has also been determined that ionization of an atmosphere is decreased as soon as the room is occupied.

Discussion

In discussing this paper, W. A. Evans pointed out that Dr. Winslow maintains that there is something still unknown about the atmosphere that makes it particularly invigorating on certain occasions, which condition cannot be reproduced by present known means of air conditioning.

NOISE ELIMINATION

It was pointed out by C. B. Graves that noise impairs the hearing, reduces the efficiency of workers, lessens production, retards concentration, interferes with sleep and normal development of infants and

children. It produces a profound effect upon the nervous system and causes other disturbances indicated by the strain of vibration in heightened pulse rate, heightened blood pressure and heart irregularities, and most important, increase of brain pressure.

Noise problems may be classified into three major groups: 1. Street noises. 2. Industrial noises. 3. Indoor noises as concerned with commercial and living conditions.

In air conditioning, a duct can be likened to an old-fashioned speaking tube, and unless lined, mechanical noise will be transmitted through it. An unlined 10x 10-in. duct 30 ft. long with an air velocity of 3,000 ft. per min. and having a noise level of 54 decibels, has been demonstrated when soundproofed to handle two-thirds more air with the same noise level. In using the unit air conditioner, outside air is brought in through a ventilating duct. This air brings in with it street noises. To overcome this, two manufacturers have developed units with silencers built into them.

A second problem in air conditioning is concerned with the absorption of noise created by the air machinery itself. This problem has been solved by some manufacturers by the use of the same materials and principles that have been successful in soundproofing interiors.

A.S.R.E. DISCUSSES AIR CONDITIONING

At the annual meeting of the American Society of Refrigerating Engineers, in the New Yorker Hotel, Dec. 6, 7 and 8, refrigerating in air conditioning occupied the most prominent place in discussions. Two sessions were devoted to this subject, one a joint meeting with the American Society of Mechanical Engineers, and abstracts of the papers presented at this meeting are part of the report of the A.S.M.E. meeting. Papers concerned with domestic refrigeration problems occupied attention of the refrigerating engineers for one entire session, while topics of general interest were discussed during the technical sessions on the first day of the meeting.

EXPANDED RUBBER INSULATION

Of particular interest was a paper on expanded rubber insulation by H. D. Edwards. Up to now expanded rubber insulation has been made only in England, and is known under the trade name of "Onazote." Onazote is made of a crude or reprocessed rubber, which is partially vulcanized by placing it in a pressure vessel that can be heated externally. After the dough is placed in the pressure vessel, nitrogen gas is admitted until a pressure of 3,000 lb. per sq.in. is reached. The pressure vessel and its contents are then heated with steam until the pressure reaches about 4,000 lb. per sq.in. As a result of the intense pressure, the nitrogen is driven into the pores of the dough. At the same time, the expansion of the absorbed nitrogen, resulting from the heating, causes the dough to expand. In the meantime, the application of heat causes a partial vulcanization of the dough, so that when it is removed from the pressure vulcanizer it has a consistency somewhat like that of a rubber eraser or a piece of soft packing material. This material is reported to have a thermal conductivity of 0.2 B.t.u. per sq.ft. per hr. for 1-in. thickness for one degree difference in temperatures. Its conductivity is shown to be lower than that of slag wool and cork.

When made up in board form it has a density between 5.5 and 5.7 lb. per cu.ft. Its yield point is in the neighborhood of 68 lb. per sq.in. Ozanote, kept in water for 110 hours, absorbs 0.4 per cent of water by weight, which, however, is reduced to 0.002 per cent of its original weight after exposure to the air of the room for 48 hours.

WATER REFRIGERATION

The condenser water problem was discussed by W. L. Fleisher in, "Water Refrigeration." This paper shows, from a theoretical angle, and in curve form, the variation in capacity and horsepower with different ranges of condensing water temperature and the quantities of condensing water required under various conditions of suction and head temperatures with different types of refrigerants. Refrigerants considered are ammonia, methyl chloride, dichlorodifluromethane and water vapor. Results plotted are theoretical in so far as the mechanical and volumetric efficiencies are concerned, and do not take into account the inefficiencies of the apparatus in which the refrigeration is developed. Assuming that the over-all efficiency of the apparatus is consistent for the different types of machines and different refrigerants, the comparative requirements would remain unchanged.

AIR CONDITIONING

At the closing session, three papers were presented on air conditioning. In "Methods of Passenger Air Cooling," F. L. Sahlmann pointed out that the railroads were endeavoring to regain passenger traffic lost to private cars, buses and airplanes by the installation of air conditioning. Statistics quoted from the Baltimore & Ohio Railroad showed that in its run between New York and Washington it had averaged 100 passengers per day before it installed air conditioning in its trains. After the installation of air conditioning, average passenger traffic handled per day jumped to 600. With this increase, the installation of air conditioning would be paid for in 24 days. Apparently, however, this increased traffic came mostly from competing railroads, rather than from buses, passenger automobiles or airplanes.

The paper described the various methods of air conditioning Pullman cars and discussed in detail problems involved in the drives for the air-conditioning equipment.

W. C. Goodwin presented a paper which reviewed the various unit air-conditioning equipments available for use in restaurants, offices and stores.

Air conditioning in a rayon plant was discussed by W. F. Giles, in a paper which describes the process of rayon manufacture and indicates the points in its manufacture where refrigeration and air conditioning are required.

The particular operating problem encountered in the air conditioning system in this industry was plugging of the nozzles in the air-washing equipment. It has been the practice in the plant under his supervision to maintain complete stands of nozzles ready so that they may be inserted in the air washer, instead of changing individual nozzles. Another trouble encountered is that of corrosion in the air washer. For this reason, the pH value of the water is checked at frequent intervals and maintained at a pH of 7. Air washers are cleaned every week. Soda ash was first used to correct the acid condition of the water, but it was found that better results are obtained with caustic soda when considerable quantities of CO_2 are in the returned air.

STANDARDS IN REFRIGERATION MEASUREMENT

In June, 1933, a Committee on Standards of Measurement was appointed, whose function was to overhaul, modernize and coordinate the various definitions and standards of the society. This was made necessary because standards have rapidly become obsolete, due to the widening of the field of refrigeration application; second, because the terminology in use was to a high degree ambiguous and confusing, and, third, there are already other committees working on other standards, and it is desirable that all of the standards existing, and to be set up, be coordinated. The report of this committee was presented by A. B. Stickney.

The report first stressed the confusion centering around the use of the "standard ton" and "standard commercial ton." The standard ton is defined as a quantity of 288,000 B.t.u. of heat removed. The standard commercial ton is defined as the rate of heat removal of this amount per day. Both of these terms are shortened to "ton" for common usage, and the resulting confusion is obvious. The report suggested the use of "ton-day" in place of "standard ton," meaning 288,000 B.t.u., and the use of the word "ton" as a rate of refrigeration of 200 B.t.u. per min.

The report also pointed out that the widening field of refrigeration made the standard condition of 5-deg. evaporation temperature and 86-deg. condensation temperature no longer representative, and, in fact, in many cases and with certain equipment, unattainable. The purpose of the "standard conditions" was to provide a basis on which complete refrigerating systems could be compared.

Several methods and ways of overcoming the objection to the "standard conditions" have been proposed, all of which, however, seem to have objections, and the committee has asked for suggestions on other methods that might be used as a basis for comparing refrigerating systems.

REVIEW OF

POWER and MECHANICAL EQUIPMENT

● IN THE pages that follow **Power** presents its sixth annual review of new and improved equipment.

● THE descriptions here presented are summaries of those which have appeared in **Power** since January, 1933.

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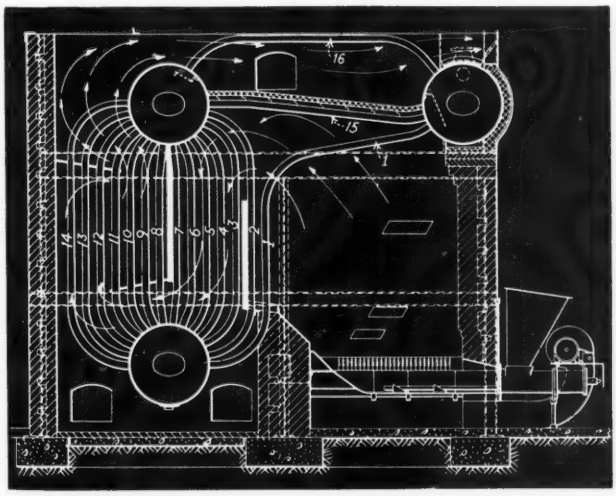
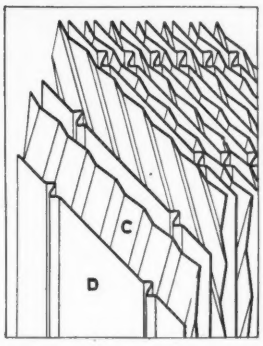
Boilers, Refractories and Accessories



Low-Headroom Boiler

Replaces old 72-in.x18-ft. H.R.T. boilers used in breweries. Sufficient furnace volume for 225 per cent rating at 1 cu.ft. per developed hp. No. 1 and No. 2 tubes keep furnace temperature within safe limits. Three-quarters of steam generated in rear drum, and, passing over Tube 16, picks up some superheat. Boiler 18 ft. 2½ in. long and brick-work is same as for regular 1,500-sq.ft. H.R.T. boiler. Can be built for any pressure up to 400 lb.—*Wm. Bros Boiler & Mfg. Co., Minneapolis, Minn.*



New Heating Surface for Air Preheaters

Permits reduction in preheater volume, weight, and in fan power requirements for a given delivery. Crimped sheets *C* have their undulations sloping at 30 deg. to path of fluid travel, and in opposite directions in alternate sheets. Corrugated sheets have been replaced by flat sheets *D* having longitudinal spacing ribs. Tests said to have developed highest rates of heat transfer known to regenerative heat surface, and show marked reduction in resistance to flow. Capacity and recovery of old Ljungstrom heater can be substantially increased by substituting new heating surface.—*Air Preheater Corp., Division Superheater Co., 60 East 42nd St., New York, N. Y.*

Hot-Rolled Seamless Boiler Tubes

Hot-rolled, seamless-steel boiler tubes. Exceptional ductility. Tubes lend themselves to rolling in and beading. Surfaces both inside and outside smooth, to retard corrosion and minimize depreciation.—*Jones & Laughlin Steel Corp., Pittsburgh, Pa.*

8,000 to 40,000-lb. per Hr. Steam Generator Unit

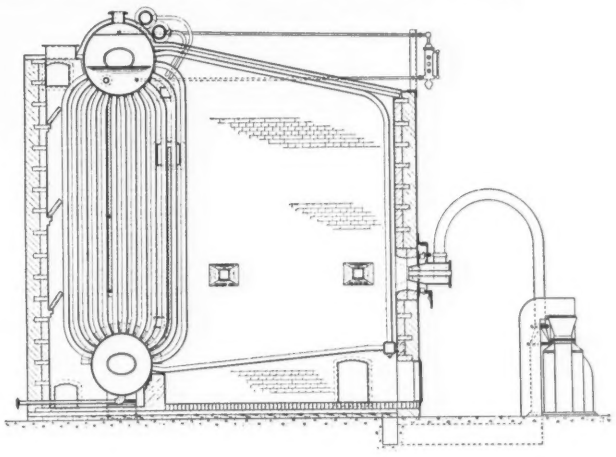
Standard design in sizes for capacities of 8,000 to 40,000 lb. of steam per hr. Economical, compact, fired by pulverized fuel, oil or gas. Low headroom and small floor space. Comprises 2-drum vertical boiler and furnace with brick walls, top and front being water-cooled by tubes connecting into upper boiler drum and terminating in a header in lower front wall. Water screen across furnace connects this header with lower boiler drum. Boiler can be arranged for either two or three gas passes and may be equipped with superheater. Single contract and performance guarantee covers entire unit.—*Combustion Engineering Co., 200 Madison Ave., New York, N. Y.*

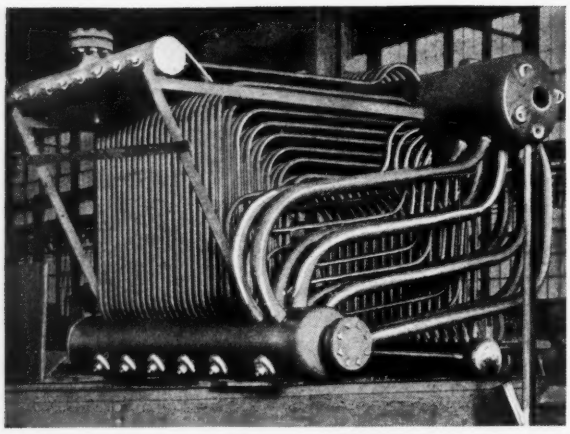
High-Temperature Brick

"Alumino Hi-Temp" block and brick, low in heat conductivity, capable of resisting temperatures up to 1,900 deg. F. Made of monohydrated bauxite. Bonded with asbestos and refractory material. Density, blocks about 26 lb. per cu. ft. brick 28 lb. Thicknesses up to 4 in.; half blocks 9x18, double bricks 4½x18x2½. Also in cement form.—*Philip Carey Co., Lockland, Cincinnati, Ohio.*

Firebrick

80 Junior handles moderate services between fire-clay refractories and 80 firebrick. Melting point 3,175 deg. F., and pyrometic cone equivalent, 33. Claimed unusually resistant to spalling, and to have high load-carrying capacity. Weight, 7½ lb. for 9-in. straight brick.—*Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.*





Small, High-Pressure Boiler

Produces saturated steam at maximum pressure of 715 lb. gage. Boiler consists of three drums connected by bent tubes and built around water-cooled furnace. All tubes within setting are steam-generating; circulating tubes outside setting between upper and lower drum. Combustion gases make two passes across boiler water tubes and single row of steam-drying tubes. Steam removed from drum through steam-drying tubes connected to manifold pipe outside boiler setting. All water tubes 1 and 1½ in. O.D., except downcomers between upper drum and other lower drum are 3 in. O.D. Unit fired by single oil burner in side wall.—*Foster Wheeler Corp., 165 Broadway, New York, N. Y.*

Refractories

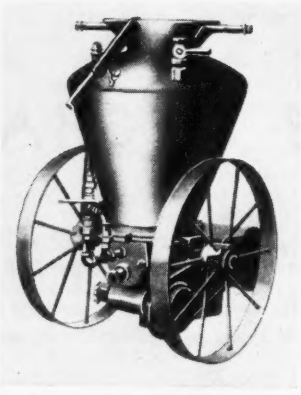
"Fireco" refractory and special products designed to requirements. "Firecast" concrete for refractory shapes and monolithic linings in 100-lb. bags. "Fireset" cements for bonding and coating, shipped in air-tight resealable steel drums from 1- to 500-lb. "Forecoat" prepared coating material has paint consistency with good adherence and surface protection. Shipped in steel drums. "Firepatch" plastic refractories have low shrinkage. Shipped in 100-, 250- and 500-lb. resealable drums.—*Findlay Refractories Co., Findlay, Ohio.*

Stoker-Boiler Unit

Spencer combustion stoker and boiler is balanced unit, consisting of automatic underfeed ram-type stoker and steel heating boiler. Capacities from 6,400 to 40,000 sq.ft. of steam radiation. Designed for smokeless burning of high volatile coal. Boiler proper delivered in two units with bridge wall built in, thus eliminating expenses of bricking. Boiler built by Spencer heater Co., division of Cord Corp., stoker by Riley Stoker Corp. Unit sold by — *Spencer Heater Co., Williamsport, Pa.*

Desuperheater

Based on new principle which combines complete desuperheating with steam purification. Essentially an assembly of contactor and Tracyfier (steam purifier) equipped with boiler feed-water regulator. Unit inherently automatic and built to A.S.M.E. code.—*Blaw-Knox Co., Pittsburgh, Pa.*



Refractory Applicator

"Gunitor" lighter, smaller units include one-man type operated by motor and with electrical remote control. Also Combine-Gunitor with gasoline engine, air compressor, water pump and Gunitor on same chassis. Capacities 40 cu.ft. per hr. to 250.—*Gunitor Co., Elkhart, Ind.*

Electrically Welded Boiler Tubing

After production of more than a billion feet of mechanical and structural tubing by Johnston electrical resistance method, (process shown at page foot) now applied to production of boiler tubing. Complete range of sizes for fire- or water-tube boilers, bent- or straight-tube type. Flat strip steel is propelled cold through series of rolls of varying contour, forming a butted cylinder which, with edges closely aligned, is passed under two revolving wheel-like copper electrodes. Weld accomplished instantly in continuous resistance process. Sizing rolls bring tubing to exact O.D. and insure straightness. Tube is later full normalized to stress relieve and produce uniform grain structure. Tested by A.S.T.M. methods for seamless tubing, including flattening, flaring, crushing and hydrostatic tests.

Advantages claimed are extreme uniformity of wall thickness, diameter and concentricity, smooth scale-free surface inside and outside of tube.—*Steel & Tubes, Inc., Cleveland, Ohio.*

Furnace Glaze

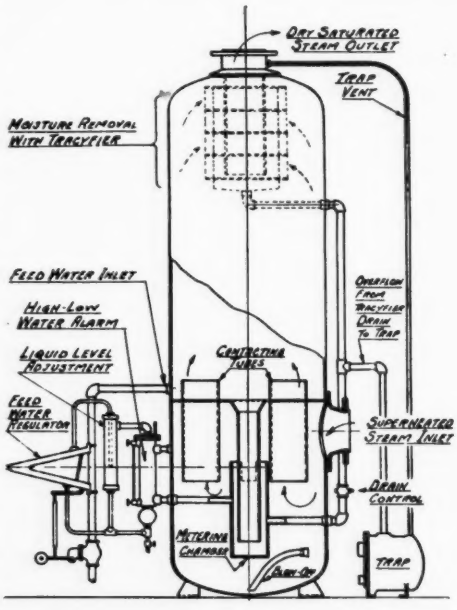
"Fire-Kote" furnace glaze or vitrified coating for refractory walls does not contain silicate of soda, fuses progressively between 1,200 and 2,800 deg. F. and does not refuse or run at much higher temperatures. Will not check or flake off.—*Mildon Engineering Co., Inc., 25 Broadway, New York, N. Y.*

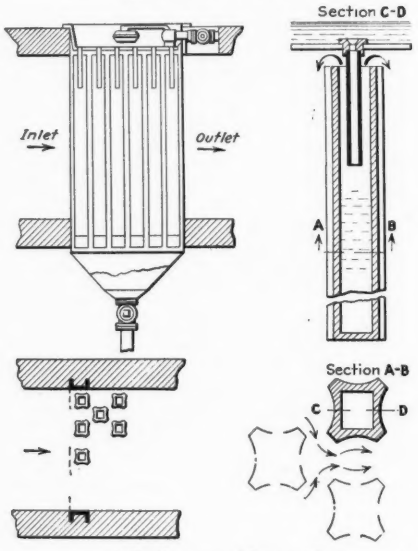
Plastic Masonry Mortar

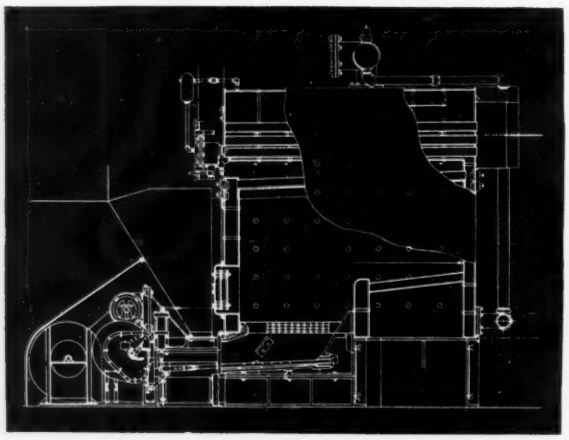
"Cobbsment" has low shrinkage factor. Can be used for flue linings, chimney brickwork, or for boiler settings where temperatures do not exceed 900 deg. F. Waterproofed, high workability, high bonding strength, high compressive strength.—*Glencoe Lime & Cement Co., 1608 Pine St., St. Louis, Mo.*

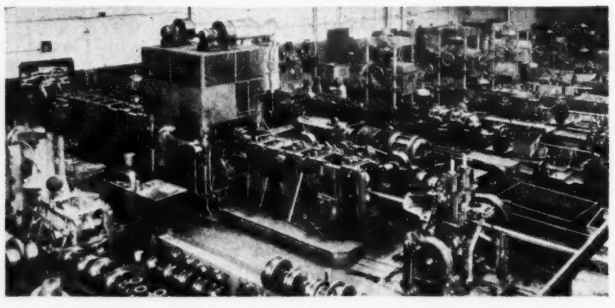
Dust Arrester

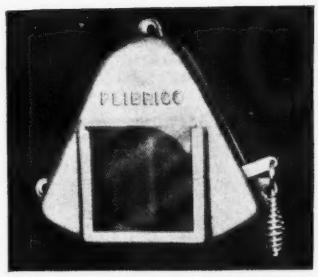
Hanrez-Modave unit, averages 95% dust removal for many installations. Also reduces sulphur fumes; if specially constructed will remove practically all sulphur and all solids in stack gas. No moving parts. Gases to be cleaned are brought in contact with changing film of water flowing over vertical concave elements.—*C. Q. Campbell, 220 Bigham St., Pittsburgh, Pa.*





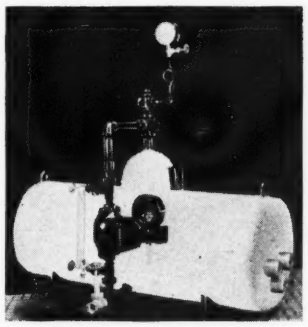






Observation Port

Inexpensive, for observing furnace conditions in boilers and other types of furnaces. Divided cover opens easily, closes automatically. Equipped with blue Pyrex glass to protect eyes of operator. — *Plibrico Jointless Firebrick Co., 1800 Kingsbury St., Chicago, Ill.*

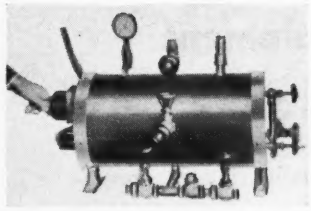


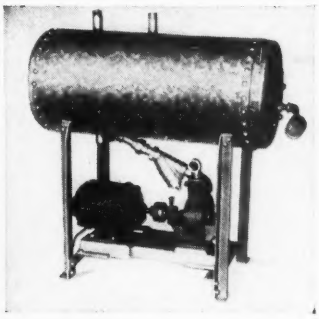
Electric Steam Generator

High- or low-pressure steam. Ratings 2 to 240 kw. Two pressure ratings, 100 and 200 lb. Quantity of steam may be flashed without reducing normal pressure with aid of an accumulator or flash capacity.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

Miniature Electric Steam Generator

Miniature generators, 2, 3, 4 and 5 kw. capacity. Sizes correspond to 6, 9, 12 and 15 lb. of steam per hour. Operate on any electrical circuit, d.c. or a.c., in all steam pressures, ½ to 100 lb. gage. G.E. "Helicoil" full-immersion heating unit. ASME safety valve, pressure gage, and similar equipment. — *Commonwealth Electric & Mfg. Co., 83-105 Boston St., Boston, Mass.*



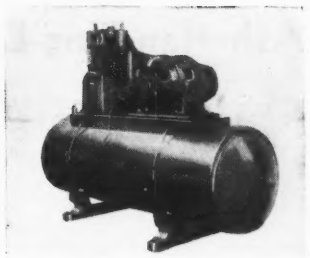


Automatic Boiler-Feed Unit

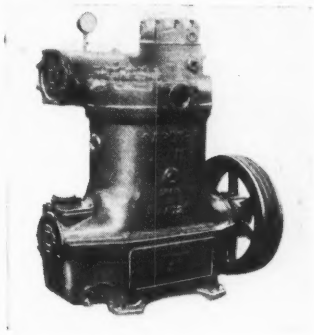
Improved M-K-O automatic unit will maintain feed-water level against high boiler pressure. Also returns condensation to boiler and supplies make-up. High-speed motor-driven turbine pump. "Flat" head supports valve and float of make-up water control. — *Mears-Kane-Ofeldt, Inc., 1903 E. Hagart St., Philadelphia, Pa.*

Water-Softener

"Inversand" zeolite units clarify and soften waters containing appreciable temporary or carbonate hardness. Accessible, compact and automatic, and softened water claimed clear, 100 per cent soft and to meet ASME specifications in sulphate-carbonate ratio.—*Hungerford & Terry, Inc., Clayton, N. J.*

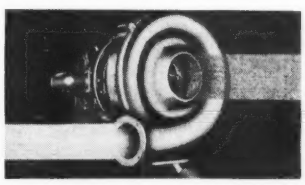


By changing size of high-pressure cylinder, machines are suitable for pressures of 15 to 1,000 lb. per sq.in. Bulletin AA-6. — *Gardner-Denver Co., Quincy, Ill.*



Duplex Vertical Two-Stage Compressor

3x2x2½ ADA compressor is used for air service and in modified form for engine starting. Pressures as high as 350 lb. Fine type air-cooled intercooler, drop-forged crankshaft, and silent plate valves. Bulletin AC-6.—*Gardner-Denver Co., Quincy, Ill.*

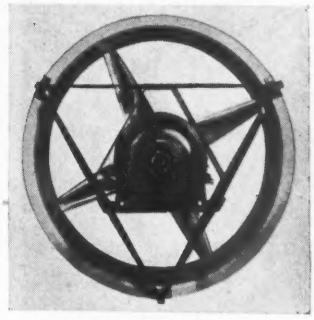


Combined Blower and Dust Collector

"Roto-Clone" dynamic precipitator is exhauster and dust separator combined. Unit no larger than usual exhauster and efficiency as great or greater than two units formerly used. Any drive. Bulletin 270-F.—*American Air Filter Co., Inc., 1st & Central Aves., Louisville, Ky.*

Single-Stage Belt-Driven Air Compressor

For heavy-duty service, Class ES has one horizontal, double-acting cylinder and operates at moderate speeds. Sizes, 10-125 hp., discharge pressures 5-150 lb. Will handle poisonous or inflammable gases. Crankshaft on Timken bearings.—*Ingersoll-Rand Co., 11 Broadway, New York, N. Y.*

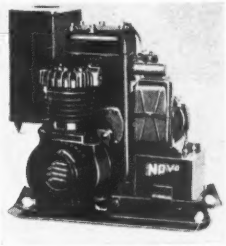


Ventilating Fans

Sizes from 16- to 36-in. diameter, both 2- and 4-blade. Capacities range from 1,450 c.f.m. for 16-in., 2-blade unit, to 18,000 c.f.m. for 36-in., 4-blade type. Blades aluminum forgings. Motor supports sheet steel welded to form rigid structure with minimum resistance to air flow. Intake rings of sheet steel rolled to shape, then welded to form continuous ring, similar in shape to intake end of aerodynamic wind tunnels. Thus ring decreases resistance to air flow and reduces tip losses. Called "Venturiflow."—*Bendix Products Corp., South Bend, Ind.*

Motor-Compressor

"Motorcompressor" requires no cooling water. Has built-in motor, with rotor on compressor shaft and frame bolted to compressor crankcase. 2-cyl., 2-stage. Sizes 20 to 50-hp., 113 to 310 c.f.m. and discharge pressures up to 125 lb. gage.—*Ingersoll-Rand Co., 11 Broadway, New York, N. Y.*



Engine-driven Compressor

Especially adaptable for oil and gas engine starting. Operates by automatic impulse coupling. Vertical automotive type. Radiator or hopper cooling. Run on gasoline or natural gas. Compressor of vertical or angle type, air-cooled. Single- or two-stage type. Monobloc-type drive compressor built integral with engine, or engine with V-belt close-coupled drive. —*Novo Engine Co., Lansing, Mich.*

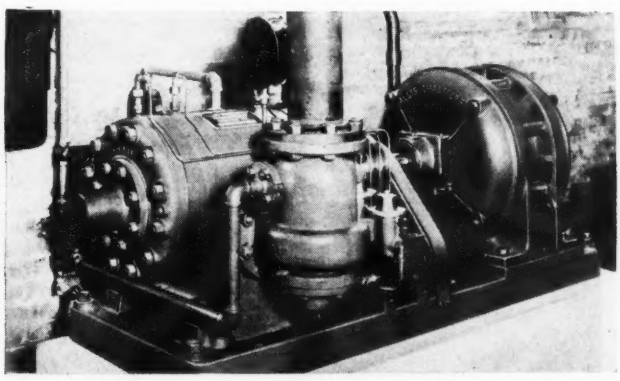
Blowers, Fans, Compressors

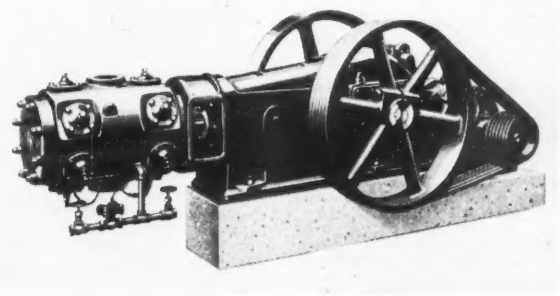
Single-Stage, Water-Cooled, Rotary Air Compressor

Complete line of rotary air compressors and vacuum pumps of multi-cellular, sliding-vane type, covers volumes from 50 to 2,000 c.f.m. at pressures up to 150 lb. and vacuums to 29.85 in. of mercury. Air-cooled units for pressures up to 10 lb. gage, and vacuums up to 18 in. Hg. Water-cooled for higher pressures and vacuums. Operate at standard motor speeds. All working parts inclosed, but accessible. — *Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

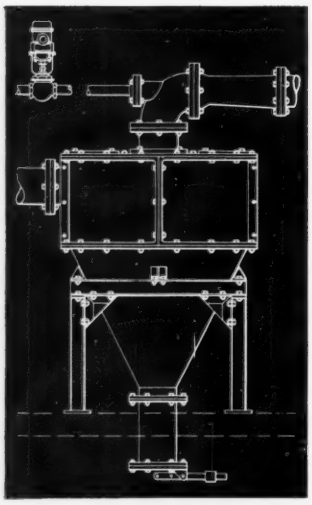
Two-Stage Compressor

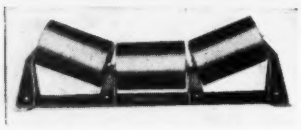
Gardner-Denver, 5x2x4, duplex, high-pressure compressor is primarily for diesel starting.





Coal- and Ash-Handling Equipment





Roller Bearing Idler

Fairfield idler for belt-conveying systems uses Timken roller bearings. Both troughing and return roller types. Demountable, interchangeable. Threefold labyrinth grease seals. Belt widths 14 to 60 in.—*Fairfield Engineering Co., Marion, Ohio.*

Pneumatic Transport System

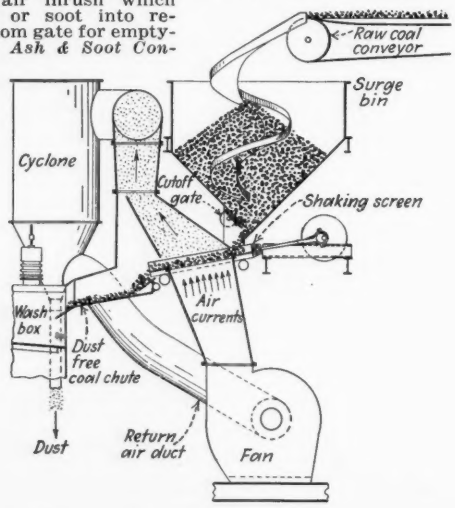
No moving parts and no motor drives required in this pneumatic conveying system for pulverized coal and other fine materials. Includes automatic weighing tank. Air in weighing container forced through transport line between loads, in order to clean out dust. Controlled by pilot valve, which is in turn controlled by upward and downward movement of container as it is being emptied and filled. Pistons adjustable for timing.—*Kennedy Van Saun Mfg. & Eng. Corp., 2 Park Ave., New York, N. Y.*

Tankless Suction Conveyor System

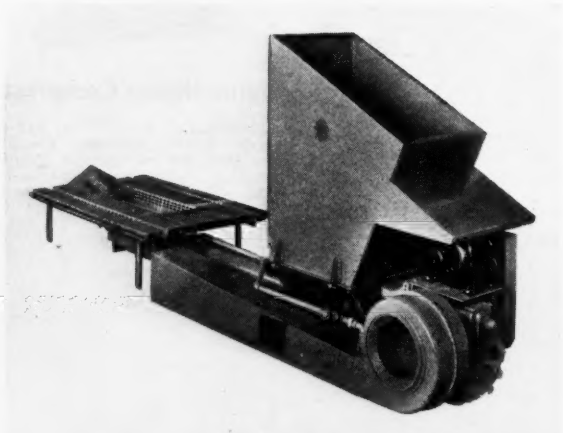
Vasco suction ash conveyors use separating receiver illustrated for collection of ashes for short period. Hard white iron receiver for ashes, sheet steel for soot. Time-cycle contactor electrical motor valve used for intermittent operation. Positive blower can be substituted for steam - operated vacuum producer. Exhausting steam in tank causes air inrush which carries ashes or soot into receptacle. Bottom gate for emptying.—*Vacuum Ash & Soot Conveyor Co., Inc., Wilson Ave., Newark, N. J.*

Dust Extraction and Collection System

Simon-Carves dust extraction and collection system. Raw coal is carried in by conveyors, elevators or other means, delivering into bin down spiral chute. Bin fitted with control gate regulating feed to shaking screen. Air blown from fan through duct leading up through screen. Thus dust is carried through top duct to a cyclone, where it settles, and is taken out through dust chute at bottom. Large coal passes over screen and is delivered by chute into wash box or storage bin. Entire mechanism driven by one motor. No cascading of coal. Cyclone 4½ ft. in diameter. 20-hp. motor will drive 50-ton plant. — *Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.*



Fuel-Burning Equipment



Worm and Distributor Stoker

Iron Fireman automatic coal burners for 1,000- to 2,500-sq.ft. boilers designed to burn different types of low-volatile, high-coking coal. Worm conveyor driven by continuous feed gear case conveys coal to retort entrance, where distributor delivers coal uniformly into combustion zone. This combination feeds coal into combustion zone without packing and with continuous movement that keeps coke formation of such size and condition that air can penetrate for efficient combustion.

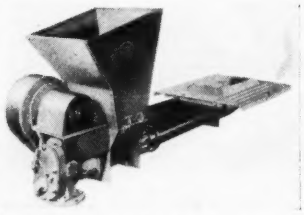
Other features: self-cooling tuyeres of special design, easily replaceable safety shear pins, over-sized fan which gives conservative overload capacity.—*Iron Fireman Mfg. Co., Portland, Ore.*

Combination Oil-and-Gas Burners

Combines features of B & W mechanical-atomizing oil burner with efficient method of burning gas. Heat-liberation capacities up to 70,000,000 B.t.u. per hr. per burner, using natural gas.—*Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.*

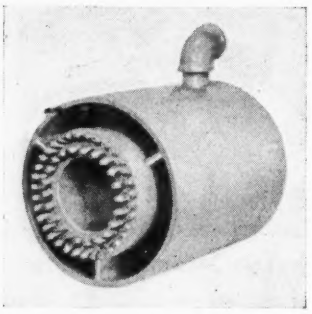
Multi-Fuels Burner

Adapted to combination firing through refractory burner walls and suited to small and moderate - sized industrial boiler units. Burner, of horizontal turbulent type, combines B & W circular burner and B & W mechanical - atomizing oil burner, with necessary additions for burning gas.—*Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.*



Automatic Underfeed Screw Stoker

For boilers having 100 to 2,500 sq.ft. of heating surface. Unusual motor mounting, permitting direct connection to forced-draft fan and accessible, compact assembly. Variable-speed transmission. Safety shearing pin. Chrome-steel screw conveyor.—*Link-Belt Co., 2410 W. 18th St., Chicago, Ill.*

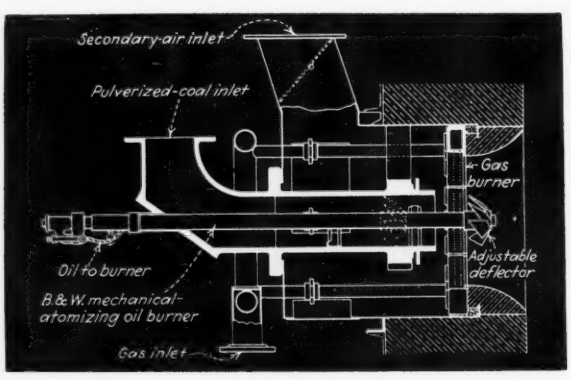


Gas Burners

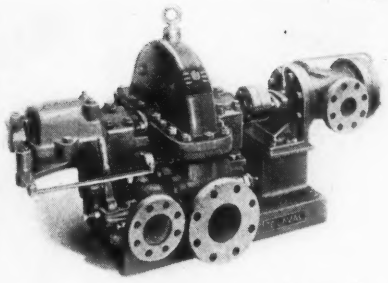
Cylindrical construction claimed to achieve complete combustion. Installed easily in any burner. Simple to operate, flexible. Adjusted to higher or lower gas pressure. Can be operated with automatic controls and burner damper, and with either natural or forced draft. Oil burner standby can be inserted through burner core in 30 sec. Oil and gas may be fired at same time.—*Ritter Gas Burner Corp., P. O. Box 321, Fort Worth, Tex.*

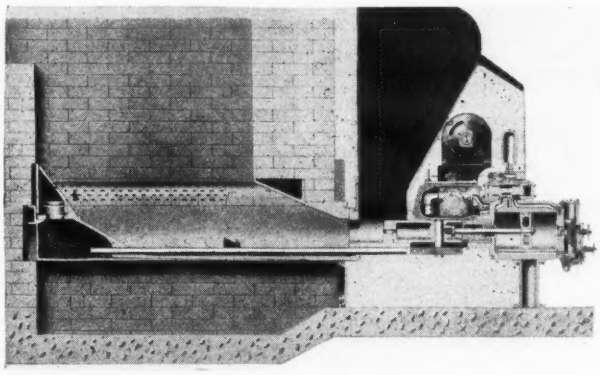
Rotary Displacement Pumps for Oil Burners

De Laval-IMO pumps are adapted for either turbine or motor drive. With turbine drive, pressure-control device gives smoothly variable speeds. Direct-coupled unit illustrated has, at 3,000 r.p.m., capacity of 150 g.p.m., against 160 lb. pressure when pumping light fuel oil of 35 to 55 SSU. at 100 deg. F. If speed-reducing gear is interposed between turbine and pump, turbine runs at 3,500 r.p.m. Reduced in ratio 3.04 to 1, pump, at 1,150 r.p.m., has capacity of 90 g.p.m. on heavy



fuel oil of 1,000 SSU. viscosity against 300 lb. pressure. Pressures as high as 500 lb. Pump of directly-connected unit, illustrated is single-end, single-suction type, with all thrust in hydraulic balance, while the turbine-driven geared unit is of balanced, opposed-rotor type.—*De Laval Steam Turbine Co., Trenton, N. J.* (Photo at right)





Underfeed Stoker

Available as heavy-duty type both in steam drive and electro-hydraulic drive, as standard type, and with full front and no ram extensions or low front with ram extension. Automatic control regulates feeding of coal by increasing or decreasing interval of time between ram strokes. Ram always makes full stroke at full speed. Electric motor drives both heavy-duty rotary pump and direct-connected forced-draft blower. Stoker surface consists of single retort with removable top tuyeres and grates of long cooling fin design, slicing bars and heavy sectional dump-plates. Multi-zoned wind box. Treadle-operated clean-out doors.—*Flynn & Emrich Co., Holliday and Saratoga Sts., Baltimore, Md.*

Steam-Atomizing Burner

Handles heavy oil, tar, pitch and acid sludge fuels. Steam admitted to annular space around central fuel barrel and projected across each outgoing stream of fuel at nozzle plate. Single nozzle plate for all capacities; variations accomplished by varying fuel and steam pressures.—*Babcock & Wilcox Co., 85 Liberty St., New York City.*

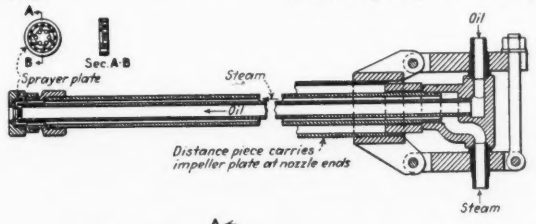
Diamond Atomizing Nozzle

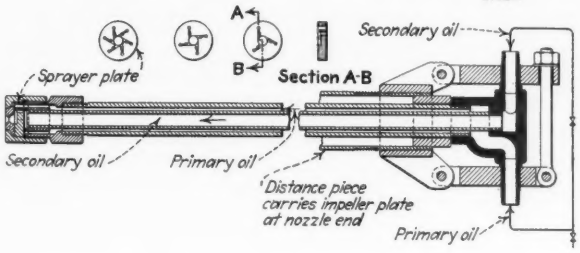
For use on all pressure burners, these diamond orifices or nozzles overcome erosive and corrosive action of grit and acids in fuel oil, providing non-wearing orifice surface of hardest substance known. Will take most delicate contours, therefore oil is atomized in proper mist for high combustion efficiency. Holds exact size indefinitely. Resists great heat. Used in connection with burner alloy guaranteed for five years.—*United States Industrial Diamond Corp., 475 Fifth Ave., New York City.*

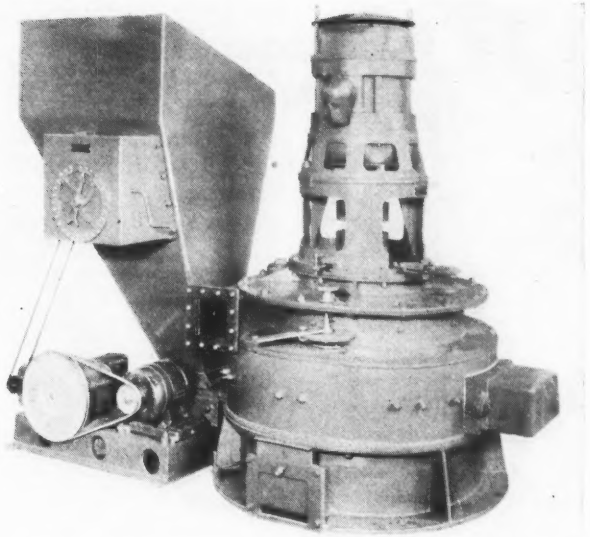
Wide-Range Oil Burner

(Diagram at page foot)

Easily adjusted to operate efficiently over a wide range of capacities. Barrel assembly shown used in standard B & W Mechanical-Atomizing Oil Burner register or as oil-burning element, of B & W Multifuels Burner. Fuel oil delivered to burner tip through two passages, outer annular passage carrying primary oil stream and center oil barrel carrying secondary oil. Both primary and secondary oil meet at one nozzle and a sprayer plate at burner tip. Capacity variation of four to one with one combination of sprayer plate and nozzle.—*Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.*





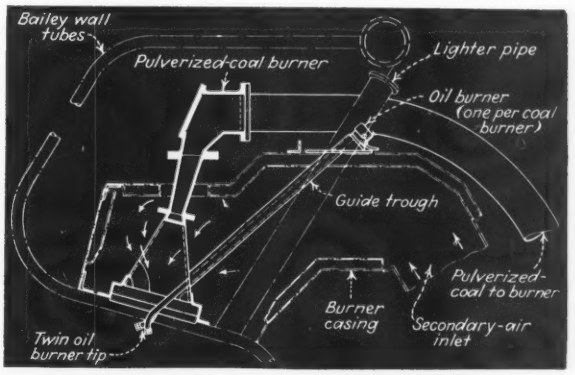


Air-Separation Pulverizer

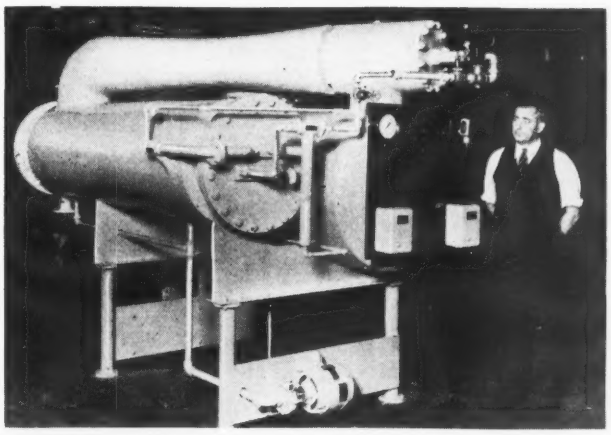
Novel principle of air separation employed in these vertical pulverizers. Material remains in pulverizing chamber until fine enough to be withdrawn by blower built integral with pulverizer and driven from its shaft. Automatic-control operation if desired. Three sizes, with capacities 50 to 3,500 lb. per hr.—*Whiting Corp., Harvey, Ill.*

Combination Coal-and-Oil Burners for Water-Cooled Furnaces

Pulverized coal burner is standard. Oil burner is twin-nozzle type inserted between two tubes in front of pulverized-coal burner, extending back and through burner casing. — *Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.*

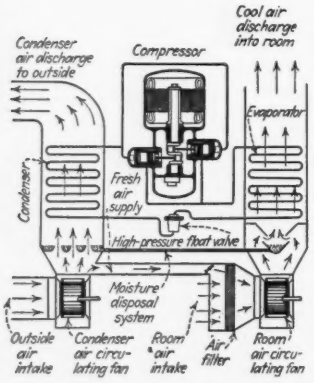


Heating, Ventilating, Refrigerating



25-Ton Steam-Jet Refrigeration Unit

Suitable for cooling water to any temperature between 35 and 60 deg. F. Unit illustrated operates on steam pressure of 100 lb. gage and has refrigeration capacity of 25 tons at 40 deg. F. Can be made to operate on any steam pressure from atmospheric up.—*American Radiator & Standard Sanitary Corp., 40 W. 40th St., New York City.*



Unit Air Conditioner

One unit in room of 5,000 cu.ft. will reduce temperature 10 to 15 deg. Can be changed from cooling and dehumidifying unit into warming and humidifying unit without an auxiliary heating system. By turning one lever, reverse refrigeration cycle is brought into action. Compressor is 2-cyl., opposed, vertical-shaft unit directly connected to totally inclosed vertical motor. Driven by 2-hp. motor and has refrigerating capacity equivalent to 1½ tons of ice meltage per 24 hr. Refrigerant is Freon.—*De La Vergne Engine Co., Sales Agent for the Baldwin Southwark Corp., Philadelphia.*

Air Cooling and Conditioning Unit

(Photo below)

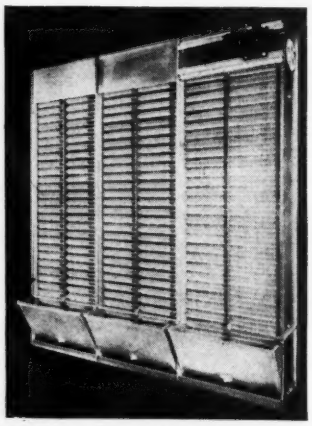
"Comfort Conditioner" uses two extended-surface copper coils, one for steam or hot water for heating, other for cold water or other refrigerant. Heating coil omitted if desired. Three sizes, 2- 4- and 6-ton cooling capacity, with B.t.u. range of 24,000 to 72,000 per hr., average temperature drop 28 deg. Heating coils have B.t.u. range of from 77,500 to 232,000 per hr.—*Buffalo Forge Co., 488 Broadway, Buffalo, N. Y.*

Electric Refrigerating Compressors (Photo at foot)

Thirty types and sizes of Freon compressors, ¼ to 20 hp. Greater refrigerating capacity per kw. input claimed because of reduction in friction. Specially machined wearing surfaces of nickel iron, packingless crankshaft sealing mechanism, Swedish steel valves.—*York Ice Machinery Corp., York, Pa.*

Instantaneous Unloader for Small Refrigerating Compressors

Automatic pressure-differential-operated by-pass valve connected between suction and discharge of compressor. Controlled by magnetic pilot valve controlled in turn by frequency-responsive relay on motor-starting panel. Automatic start and stop operation secured. Instantaneous unloader avoids shut-downs.—*Electric Machinery Mfg. Co., Minneapolis, Minn.*

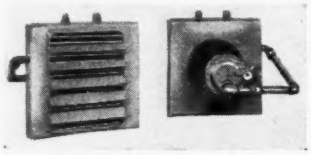


Aluminum Air-Filter

Aluminum used throughout this self-cleaning air filter to increase endurance and lengthen life.—*Independent Air Filter Co., Chicago, Ill.*

Automatic Humidity Control

Friez Humidistat has hygroscopic elements of human hair. Index hand sets controller along visible scale to maintain humidity from 20 per cent to saturation. Used with either 3- or 2-wire contacts. Contacts designed for either close range or wide range adjustment in terminals with open or closed wiring.—*Julien P. Friez & Sons, Inc., 4 N. Central Ave., Baltimore, Md.*



Turbine-Driven Unit Heater

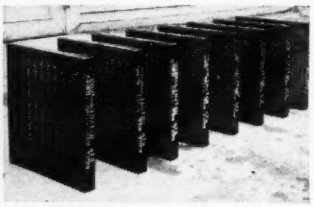
Steam admitted to Murray turbine unit heater through cast-iron header, into which are expanded several banks of heavy copper tubes with brass radiating fins. Air blown over coils by turbine-driven fans. Also available electrically driven.—*Murray Iron Works Co., Burlington, Iowa.*

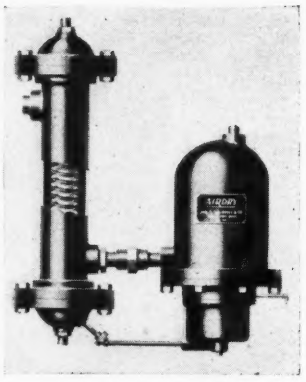
Brine Treatment

Colloidal glucosides control electrolysis by buffer effect in this H-O-H formula. Maintains pH over extended periods without addition of material. Oxygen eliminated through direct chemical combination. Treatment effective in salt or calcium chloride brine, also for prevention and removal of lime and rust deposits from circulating brine systems.—*D. W. Haering & Co., 565 W. Washington Blvd., Chicago.*

Odor Filter

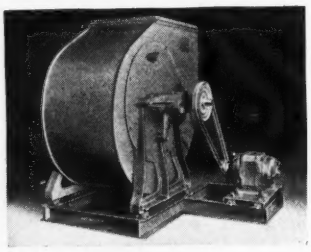
Works on gas-mask principle, passing air through bed of granular activated cocoanut-shell carbon. Can be reactivated. Unit cells mounted in four-cell cabinets. Air-handling capacity per cell, 125 c.f.m. at face velocity of 54 ft. per min. Static resistance, 0.5 in. water gage. Weight per cell, filled, 29 lb.—*Consolidated Air Conditioning Corp., 192 Lexington Ave., New York, N. Y.*





Automatic Air-Drying Device

Aftercooler-separator combination claimed practically 100 per cent efficient. Condensation in both aftercooler and separator descends into built-in automatic trap, and is ejected as fast as collected. Sizes 5 to 150 cu.ft. free air per min. Larger sizes built to order. Aftercooler of counter-current flow design.—*James A. Murphy & Co., Hamilton, Ohio.*



Silent Fan Base

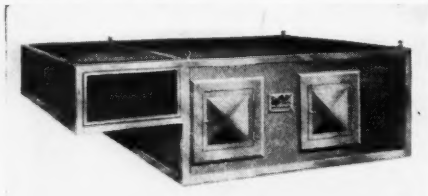
Flexible rubber insulators allow no contact between bolts or metal parts of fan and base. Insulators are in shear, giving greater life and flexibility. —*Buffalo Forge Co., 488 Broadway, Buffalo, N. Y.*

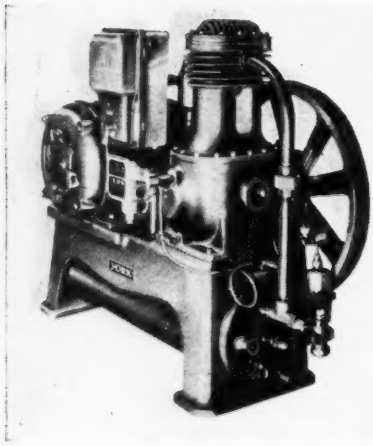
Fresh-Air Intake

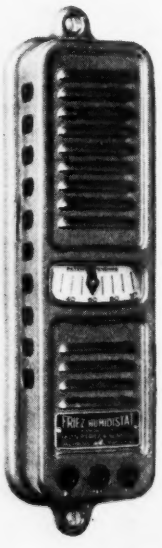
All units adjustable, smaller by hand, larger by geared power. Bronze pivots on blade ends operating in bronze bearings. Dust-protected ball-bearing operating blades furnished for thermostatic controls. Also automatic back-draft louvre with aluminum blades. — *Burt Mfg. Co., Akron, Ohio.*

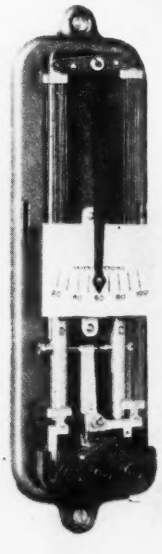
Hot-Water Heating

"Force-Flo" one-pipe system uses centrifugal pump illustrated. Claimed to triple effi-

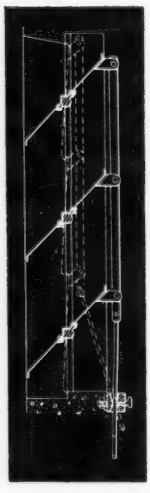


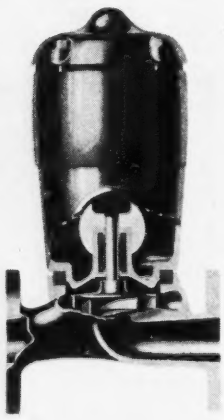




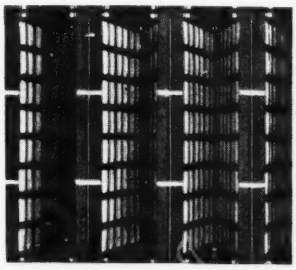


Below—Burt Air Intake



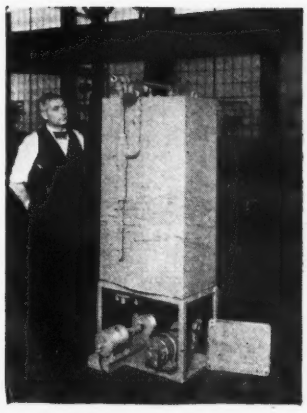


ciency. Will operate against considerable friction head. Pump motor condenser type with stainless steel shaft; rotary seal instead of stuffing box.—*Stevens-Root Co., 51 E. Grand Ave., Chicago, Ill.*



Air Filter

Series of small filters in multiple-V shape give filtering surface 27 times face area. Low velocities through positive, dry-type filter medium. Cells can be in accordion arrangement for positioning in long ducts. Standard 20x20-in. size, 4¼ in. deep and accommodating up to 800 c.f.m. Other sizes handle up to 3,000 c.f.m. at velocity of 28 f.p.m. Panel cells available with capacities 90 to 900 c.f.m.—*Staynew Filter Corp., Rochester, N. Y.*



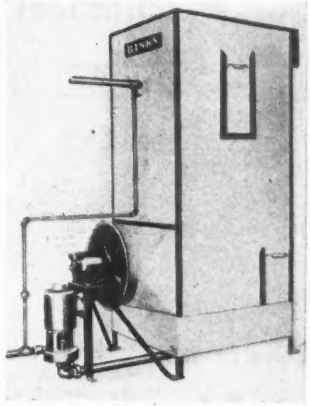
Steam-Jet Refrigeration Unit

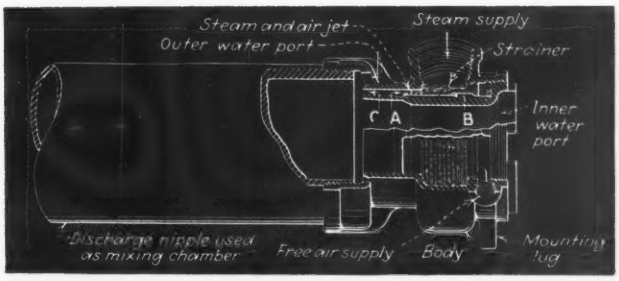
Suitable for any process requiring water between 35 and 60 deg. F. Operates on steam at 12 lb. gage and has refrigeration capacity of 2.5 tons at 50 deg. Any steam pressure from atmospheric up; sizes 2 to 20 tons. Units larger than 20 tons horizontal. — *American Radiator & Standard Sanitary Corp., 40 W. 40th St., New York, N. Y.*

perature. Each tube free to expand and change curvature independently. Distributed exclusively through Hitchen Engineering Co., Inc., 155 East 44th St., New York, N. Y. — *Griscom-Russell Co., 285 Madison Ave., New York City.*

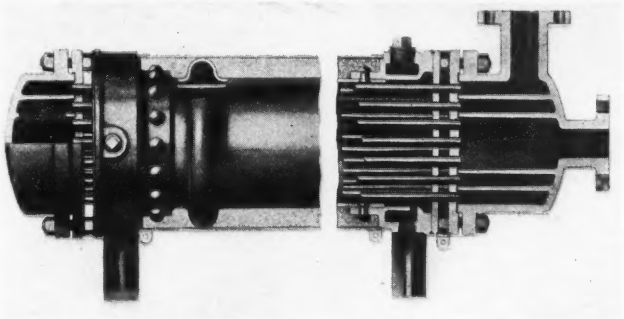
Indoor Forced-Draft Cooling Tower

Type FD spray-cooling towers are complete, self-contained, operating units, with or without water-circulating pump. Circulating pump can be mounted as shown or can be located at any convenient point between process and tower. Special Binks patent "Rotojet" clog-proof nozzles. Capacities 5 to 50 g.p.m.—*Binks Mfg. Co., Cooling Equipment Div., 3114-40 Carroll Ave., Chicago.*





Heat-Transfer Equipment

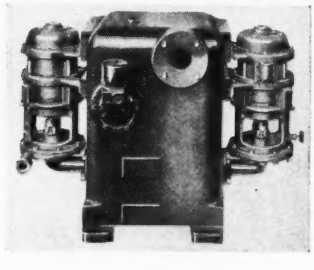


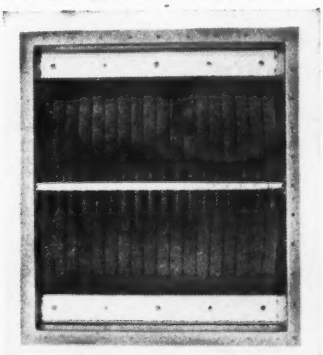
8-Pass Oil Heater

Coen outside-joint heater avoids leaky tube joint permitting oil to enter boiler, hot well or cooling tower. Tube sheets rolled steel, two at each end, with space between open to air. Expansion joint built in. Cold oil goes through center tubes and is heated as it approaches outer row. Casing at steam temperature. Steam distributed through holes on inner circumference. Steam connection at either end of heater and drain connections two at each end. Heater may be used as cooler.—*Coen Co., Los Angeles, Calif.*

Condensate Return Units

"Motorpump" units automatically return condensation to boilers from low pressure, gravity-return steam-heating systems. Cameron Motorpump with built-in G.E. motor. Units with either one or two pumps in sizes to handle up to 30,000 sq.ft. of direct radiation. Condensate reservoir is 15-, 30- or 60-gal. tank. Unit illustrated has two 1-in. motorpumps on 30-gal. cast-iron receiver. If each motor is connected to a different electrical circuit, these duplex units provide protection against current and control failures and provide additional reserve capacity. — *Ingersoll-Rand Co., 11 Broadway, New York, N. Y.*





Bent-Tube Heat-Exchanger Units

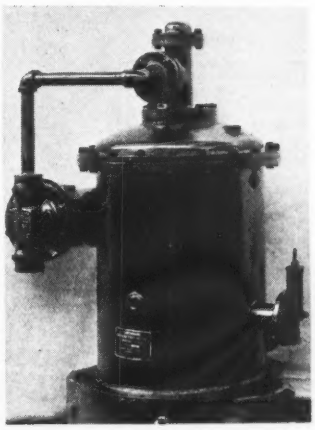
K-Fin Bentube heaters for air-conditioning, cooling, heating and ventilating systems in complete standard-size sections. Initially bowed tubes accentuate curvature on increase of temperature. Each tube free to expand and change curvature independently. Distributed exclusively through Hitchen Engineering Co., Inc., 155 East 44th St., New York, N. Y. — *Griscom-Russell Co., 285 Madison Ave., New York City.*

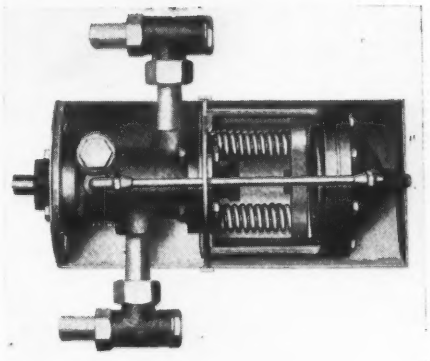
Steam-Operated Water Heater

XL-32 heats water or other liquids to any temperature up to boiling. Operating steam pressures from 3 to 140 lb. Capacities 47 to 66,800 g.p.h. — *Penberthy Injector Co., Detroit, Mich.*

Deaerating Feed-Water Heater

Multiple-jet spray used instead of conventional trays. Water heated by spraying in steam atmosphere is collected by cone-shaped bottom of heating chamber and delivered to central cone-shaped atomizing valve, from under which is discharged an upwardly directed conical steam jet. This atomizes and deaerates water, which passes to storage. — *Cochrane Corp., 17th and Clearfield Sts., Philadelphia, Pa.*



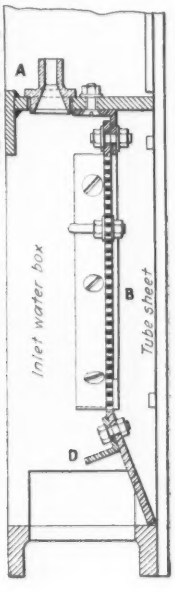


Condenser Tube Corrosion (Foot of page)

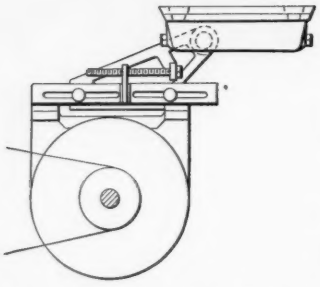
Based on theory that condenser tube corrosion is caused by oxygen in circulating water. Offtake funnels *A*, connected to discharge piping of condenser circulating water system, are in inlet water box to catch and release air. Screen *B*, of mild steel for oxygen to act upon. —*Condenser Service & Engineering Co., 310 12th St., Hoboken, N. J.*

Fixed-Ratio Water Heater

"Hydro-Heater" delivers hot water at constant temperature and flow. Essentially two orifices—one for water, one for steam—in fixed radio, metering both steam and water before they mix. No thermostat required. No moving parts. Type I for industrial use.—*Hydro-Heater Corp., First Wisconsin Nat'l Bank Bldg., Milwaukee, Wis.*

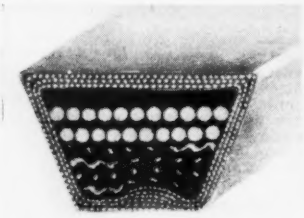


Mechanical Transmissions



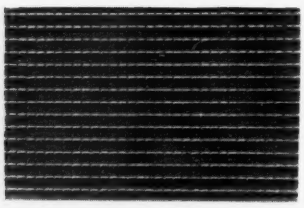
Compensating Belt Drives

Ceiling-drive bases (diagram) and vertical-drive bases are new Rockwood drives. Ceiling unit is standard except that special hanger arms suspend motor horizontally and give greater ceiling clearance. One-man adjustment while running without auxiliary support for motor. Safety chain catches motor if belt or fastener fails. Vertical-drive base differs from standard unit in that force producing tension is derived from coil springs instead of motor weight. Adjusted easily while running.—*Rockwood Mfg. Co., Indianapolis, Ind.*



Improved V-belt for Multi-V-drive

Improved Goodyear Emerald Cord V-belt now used with Worthington Multi-V-Drive. Has high power capacity, long flexing life and low stretch. Basic feature is greater concentration of load-carrying capacity about neutral axis. — *Worthington Pump & Machinery Corp., Harrison, N. J.*



Tread-Surface Leather Belt

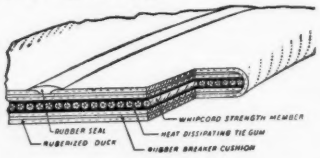
"Vim-Tred" belt has non-skid surface produced by indenting surface. Claimed to concentrate pressure between belt and pulley on ribbed tread to increase gripping power.—*E. F. Houghton & Co., 240 W. Somerset St., Philadelphia.*

Wheel and Gear Puller

Improved "Steelgrip" universal wheel and gear puller consists of heavy bracket with large pulling screw and three chains of any desired length. Will handle work at any distance from shaft end. Two capacities, 12,000 and 36,000 lb. —*Armstrong-Bray & Co., 308 Sheldon St., Chicago, Ill.*

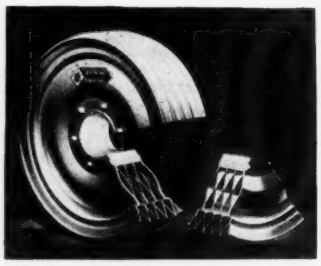
Chemically Resistant Rubber Belting

Resists destructive action of acids, alkalies and oils three times as long as ordinary belting.—*B. F. Goodrich Rubber Co., Akron, Ohio.*



Whipcord Transmission Belt

Endless-wound and without inelastic stretch, Condor Whipcord was developed for high-speed, high-tension drives. Single-layer cord section claimed equivalent to six duck plies in strength, while many times as flexible. Widths 1 to 12 in.; lengths to 75 ft.—*Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J.*

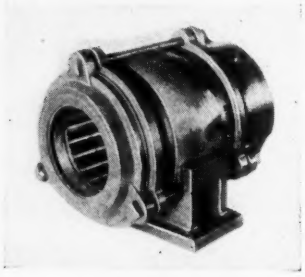


Steel V-belt Sheaves

Texrope V-belt drive with one or both sheaves "Texsteel" from ¼ to 15 hp. Grid-type construction electrically welded. Outer rims rolled. Integral bushings or solid-bored hubs standard.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

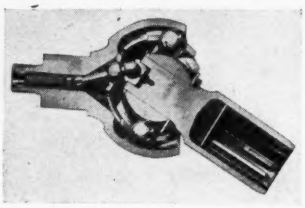
Flexible Coupling

Three parts, center member of non-metallic material, self-lubricated by means of reservoir within. Floating center member slides between jaws of one metal flange on line passing through center. Free to slide across face of second flange at right angles to first. Flanges nickel iron.—*D. O. James Mfg. Co., 1114 W. Monroe St., Chicago, Ill.*



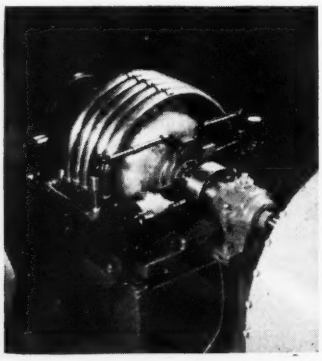
Industrial Roller Bearing

Conventional inner and outer rings and roller cage assembly. Alloy steel permits heavy-duty service. Increased roll length or two rolls of rollers provide additional capacity where necessary. Variety from 3½- to 7⅞-in. shaft diameter. Pillow block illustrated furnished with bolted-on end covers to permit easy assembly and dis-assembly. Standard single-roll radial ball bearing takes thrust load.—*Fafnir Roller Bearing Co., New Britain, Conn.*



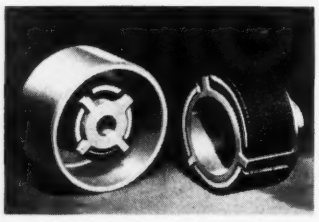
Universal Joint

Constant angular velocity, angularity as high as 37½ deg., simple construction and high efficiency are characteristics of "Rzeppa" ball-bearing universal joint. Nominal shaft diameters 1 to 2¼ in., with ratings 5,600 to 63,000 in.-lb. All parts case-hardened steel. Also 15-deg. angularity "disc-type" unit available.—*Gear Grinding Machine Co., Detroit, Mich.*



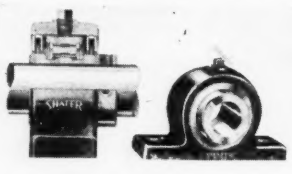
Hydraulic Coupling

Makes possible variable-speed control with constant-speed driver. For use with centrifugal pumps. Simple induction motor operates it. Gives exact speed for any discharge without usual losses. Unit shown delivers 130 hp. at 3,600 r.p.m. —*American Blower Corp., Detroit, Mich.*



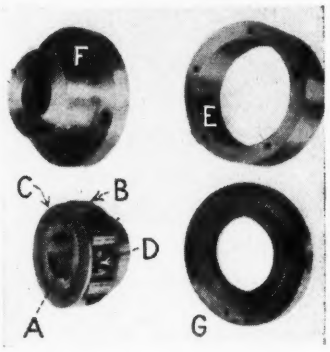
Four-Duty Coupling

Falk-Rawson 4-duty coupling starts, couples, cushions and limits load. Essentially is two drum-shaped members, inner on driving shaft, outer on driven. Between driving and driven shafts are two sets of floating segments. Outer actuated by driving member, inner by driven member. Bulletin 500. — *The Falk Corp., Milwaukee, Wis.*



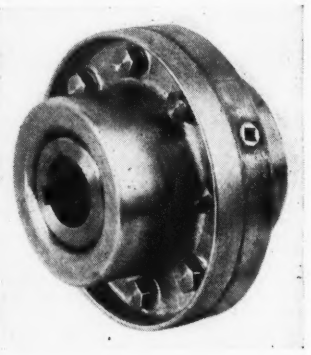
Light-Duty Roller Bearing

This line of single-row, self-aligning, radial roller bearings uses a single-row Shafer concave bearing of full roller type. Liberal radial load capacity, limited thrust capacity. In addition to pillow block illustrated, light-duty bearings available in flange units, hanger boxes and take-up units for shafts from ⅝ in. to 2 15/16 in. inclusive.—*Shafer Bearing Corp., 621 S. Kolmar Avenue, Chicago, Ill.*



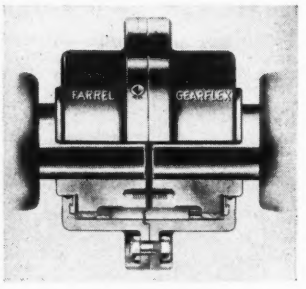
Free-Wheeling Clutch

"Kelpo" free-wheeling clutch coupling consists of drive gear *A*, cam gears *B* in cage *C*, springs *D* and case composed of ring *E*, drive flange *F* and cover *G*. *A* on prime-mover shaft meshes cam gears *B* in cage *C*, and assembly is contained in case so that it engages inner surface of *E*. Drive flange *F* is mounted on load shaft and has ring *E* and cover *G* bolted to it to make complete case which revolves with load shaft. Unit can be assembled on job to operate in either direction. Can be used for free-wheeling coupling or for ratchet.—*Morse Chain Co., Ithaca, N. Y.*



Light-Duty Coupling

Usual internal and external gears constantly in mesh. Die-cast zinc-base oil-filled casing permits low-cost unit for light duty. Hubs forged steel. Sizes 1 to 2¼ in., 2-15 hp. per 100 r.p.m. and maximum speed 3,600 r.p.m.—*Bartlett Hayward Co., Baltimore, Md.*



Gear-Type Flexible Coupling

Double-engagement type. Consists essentially of two ex-

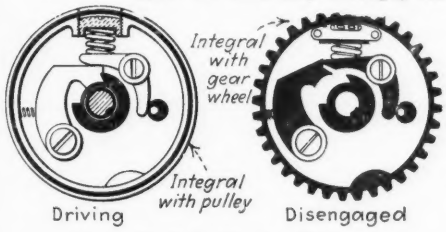
ternally geared hubs keyed to shafts to be connected and engaging an internally geared sleeve encasing them. Reservoir between hubs and floating sleeve carries lubricant. Unit also in single-engagement type with only one externally geared hub in engagement with an internal gear in sleeve, other hub being solid with sleeve bolted to it. This provides lower-cost coupling. — *Farrel-Birmingham Co., Inc., 344 Vulcan St., Buffalo, N. Y.*

Corrosion-Resisting Roller Chain

"Silverlink" has specially treated sidebars to resist corrosion. ⅜ to 2½ in. pitch, and single or multiple widths. Available with wheels for any horsepower, also with conveying attachment links. Sizes up to 225 hp., speed ratios, 1-1 to 8-1.— *Link-Belt Co., Indianapolis, Ind.*

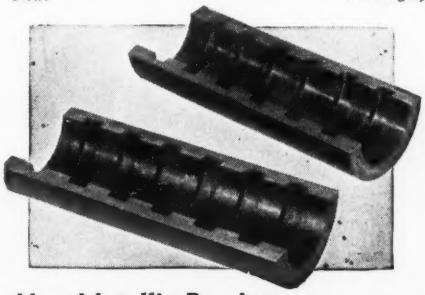
Automatic Clutch

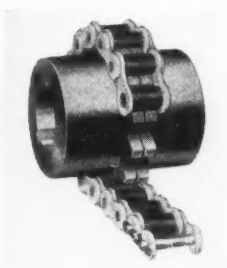
"G-O-B" clutches are practically integral with driving wheels. Driving pawl, in contact with angular contact point on bushing (which is keyed to shaft) is held in position by load spring as at left. Adjusting screw compresses load spring until pawl remains in this position, which corresponds to the safe load on machine. Any resistance or overload beyond this safe load will release pawl and throw it into a locked position, as at right. Easily reset.—*G-O-B Engineering Co., 1953 W. 63rd St., Chicago, Ill.*



Roller-Chain Flexible Coupling

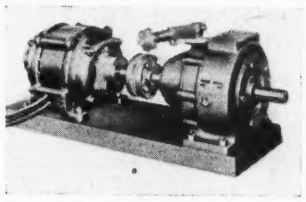
"RC" Silverlink roller chain connects two cut-tooth sprocket wheels or coupling halves. Pin-and-cotter link to couple or remove chain. Unit can be inclosed in stationary or revolving automatically lubricating oil-retaining casing. All sizes and types listed in folder. — *Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.*





Non-Metallic Bearings

Special textile base impregnated with synthetic resins, molded under high pressures. All shapes and sizes. Three basically different materials for various services; Hydrotex where bearings run in water, or where water used for lubrication. Lubritex for oil-lubricated equipment. Grafitex, self-lubricating, made especially for slow-moving machinery. Journal diameters ¼ to 24 in., and larger. One-seventh as heavy as bronze.—*Gatke Corp., 228 N. La Salle St., Chicago, Ill.*

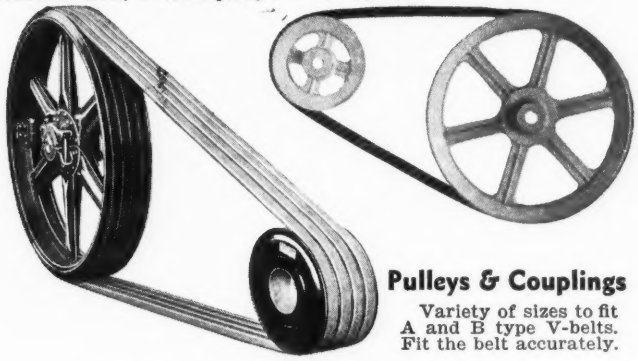


Variable-Speed Reducer

Johnson variable reducer is composed of five over-running clutch units. Self-contained, infinitely variable, run in oil bath. Unit stops instantly. Noiseless, high efficiency. Capacity 1 hp. up, speed 0-240 r.p.m.; step-up for higher speeds. —*The Smith Power Transmission Co., Penton Bldg., Cleveland, Ohio.*

Large-Diameter Steel Pulley

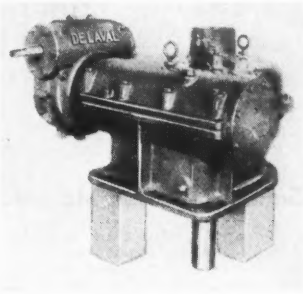
"Wedgbelt" pulleys of pressed steel in larger diameters. Utilize "American" hub and arm construction with steel grooves. *American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa.*



Pulleys & Couplings

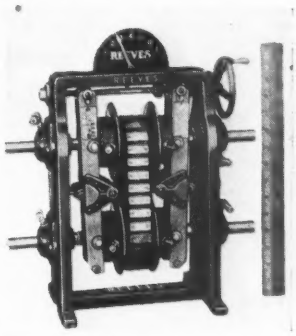
Variety of sizes to fit A and B type V-belts. Fit the belt accurately.

Die cast from white brass, diamond bored, balanced. Sizes in round-belt and V-belt types. — *Congress Tool & Die Co., Detroit, Mich.*



High-Ratio Worm Gear

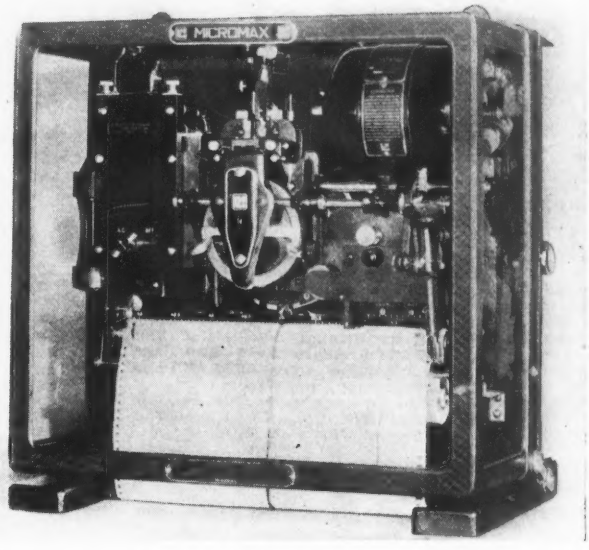
This double-reduction worm gear gives considerable latitude in respective locations of driving and driven machines. In this design the high-speed gear wheel is mounted on slow-speed worm shafts, but greater flexibility in arrangement of drive has been gained by using separate housings for high-speed gear and slow-speed gear.—*De Laval Steam Turbine Co., Trenton, N. J.*



Vertical Variable-Speed Transmission

No. 0000 vertical-type variable-speed transmission is but 15 in. high. May be equipped with motor base and individual driving motor, with auxiliary countershaft for greater speed reduction, and with extended lever-type mechanical automatic control. Also completely inclosed. Speed range, 2:1 to 6:1, capacity, ½ to ¾ hp.—*Reeves Pulley Co., Columbus, Ind.*

Meters, Recorders and Testing Instruments

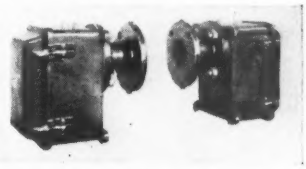


Frequency and Time-Deviation Recorder

Both system frequency and any difference in time up to 10 sec. between system time and standard-clock time are shown simultaneously on one chart of Micromax recorder. Synchronous motor in recorder checks system time and is automatically compared at 1-min. intervals with time of regular master clock. Scale only two cycles instead of usual four; each chart division represents only 0.02 cycle instead of 0.05.—*Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.*

Industrial Tester

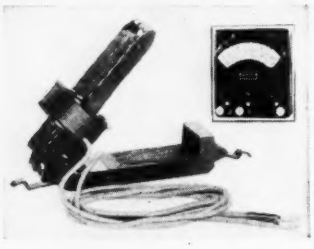
Industrial Analyzer makes complete tests up to 125 amp., 500 volts a.c. Is actually miniature, portable, 3-phase switchboard panel in case complete with necessary switching equipment, transformers and resistors. Includes miniature triple-scale ammeter, 0-5, 0-25 and 0-125 amp., triple-range voltmeter, 0-150, 0-300, 0-600 volts; polyphase wattmeter with three scales for above ranges; and polyphase power factor meter with 10-100-80 scale.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



Smoke-Density Recorder

Photo-electric unit indicates on meter. Recorder added to give running record. Comprises light source and photo-electric relay on opposite sides of stack, covered by lenses kept clean by

air drafts. Alarm circuit can be adjusted to any point between 20 and 60 per cent of full density.—*General Electric Co., Schenectady, N. Y.*

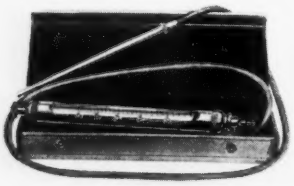


Test Set

Type CSO split-core transformer test set with Type PA or "Steel-Six" portable ammeter will give a.c. readings as low as 0.5 amp. and as high as 200 amp. Two ranges in ammeter, 2.8 amp. and 15, without transformer. With transformer, ranges 40 and 200 amp. —*Roller-Smith Co., 233 Broadway, New York, N. Y.*

Combination Instrument

For recording and controlling pressure, and recording flow. Pressure-controlling mechanism of Stabilog type. Available in flush-type or in surface-mounted case. Weatherproof door construction. Case may be built gas-tight and vented to operate on natural gas.—*Foxboro Co., Foxboro, Mass.*

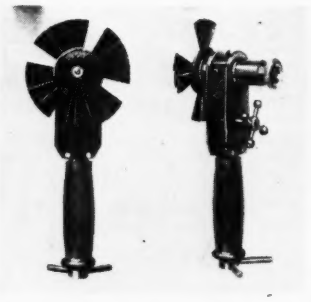


Smoke-Tube Draft Gage

Without liquids or moving parts and does not require leveling. Smoke tube filled with smoke from cigar or cigarette, and tip of flexible tube placed in draft or other air flow to be measured. Flow of air through tube causes air jet which clears smoke from upper portion of tube for distance dependent on pressure. Calibrated in inches of water.—*E. Vernon Hill Co., 121 N. Clark St., Chicago, Ill.*

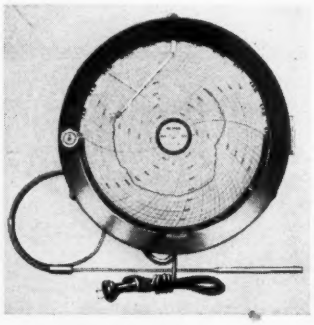
Beam-Type Pressure Transmitter

Scale beam 20 in. long balances on knife edge. On beam is motor-driven screw which moves weight toward or away from knife-edge fulcrum to balance beam. Scale on beam below moving weight reads known pressure in lb. per sq.in. Electrical contact records weight position.—*Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.*



Smoke-Emission Measurer

According to *The Engineer*, London, this instrument compares amount of light obscured by smoke with that cut off by four black disks mounted one behind another at top of handle. Each disk has four projecting vanes which may be arranged in echelon or one behind another, so that while group is spun, light obstruction can be varied from one-fifth to four-fifths. Density read on calibrated scale.—*C. F. Casella & Co., Ltd., Regent House, Fitzroy Sq., London, England.*

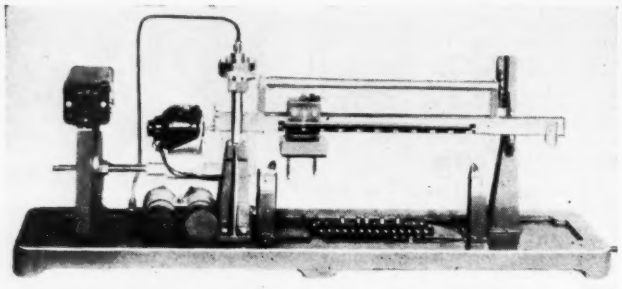


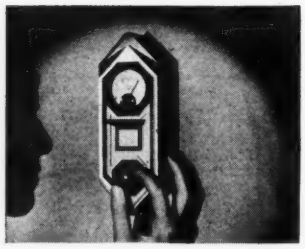
Recording Thermometer

8- and 12-in. circular-chart instruments, including indicating and recording thermometers for temperatures from—40 to 1,200 deg. F., and indicating or recording pressure and vacuum gages for ranges of 10 in. of water to 5,000 lb. All types in 1-, 2- or 3-pen models. Thermometers can be 200 ft. away. Actuating movements in pressure and vacuum gages: for ranges of 10 in. water to 30 lb., flexible metal diaphragm; 30 to 200 lb., spring-opposed bellows; over 200 lb., helix. Electric clock or hand-winding. —*Brown Instrument Co., 4490 Wayne Ave., Philadelphia, Pa.*

Hydrometer

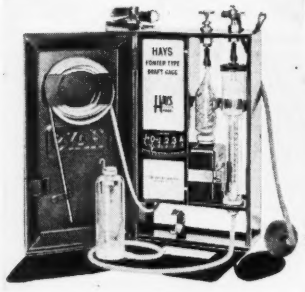
Both plain and combined forms. Longer and wider metal scales, permitting temperature determinations as close as plus or minus 0.25 deg. F. Streamline tip. Solid metal ballast; scale 25 per cent longer than usual paper scale, yellow with black figures for ease of reading. Circular 1070.—*C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.*





Multi-Temperature Indicator

Measures entire range from ice point to steam point. Accurate, can be plugged into any light socket and wired to search coils at as many extensions as necessary. Dialed to point from which reading is required.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

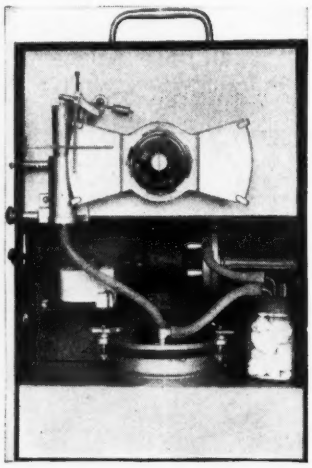


Combustion Test Set

Series 3,000 set combines fast Orsat gas analyzer (range 0-21%) with pointer-type draft gage in steel case, 7⅞x5x15 in. Wt. 9 lb. Highly sensitive draft gage has no liquids and requires no leveling. Two ranges, .1 to 0 to- .4 in. and 0 to- 1 in. Flue-gas theromometer with range 200-800 deg. F. is fountain-pen type 5 in. long, with 10-deg. graduations. Bulletin 2009.—*The Hays Corp., Michigan City, Ind.*

Compensated Air-Cell Battery

For use with Brown potentiometers, battery eliminates frequent standardizing. Constant-current output and 2½-yr. life. —*Brown Instrument Co., 4490 Wayne Ave., Philadelphia, Pa.*

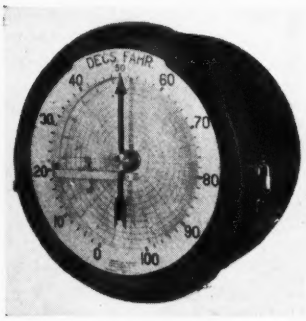


Portable CO_2 Recorder

Knurled thumbscrew at top of vertical pendulum weight to permit adjustment for calibration, to conform with Orsat tests. Bottom drain tube on water tank in which bell float works shown at left side of case. Overflow at top prevents too much water in tank. Rubber tube from bottom of bell float tank now placed in center of porous plate instead of from top of KOH tank. Small universal motor and rheostat now on detachable shelf on inside of case, and small portable Orsat for calibrating or testing recorder now placed on inside of case at back of clock plate. Rubber tubing, gas filter, etc. also packed in this compartment. — *Defender Automatic Regulator Co., 308 So. 8th St., St. Louis, Mo.*

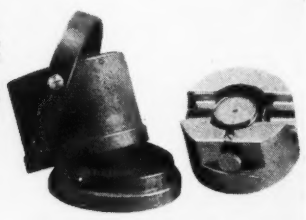
2-In. Indicating Gage

Moderate priced, Model DH has guaranteed accuracy and full-length 270-deg. scale. Uses full-length Bourdon spring. Accuracy within 1 per cent of total scale. Any range from 0-15 lb. per sq.in. to 0-300, as well as 0-30-in. vacuum.—*Foxboro Co., Foxboro, Mass.*



Round-Chart Indicating Recorders

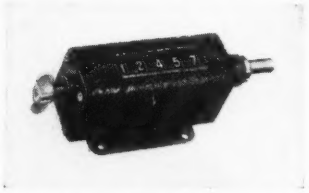
Single-point Model R "Micromax" recorders are lower in cost, but embody principle and elements of strip-chart Micromax. Has large-lettered circular scale and uses 24-hour circular chart with straight-line time coordinates. Calibrated portion is 3½ in. wide, and chart is 10⅜ in. in diameter overall. Recorder made as single-point instrument only, and can be equipped with two signal or control contacts. Potentiometers manually standardized. Case 16¼ in. diameter.—*Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.*



Portable Vibrometer

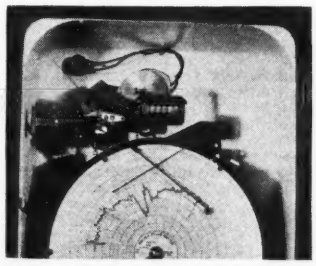
Vibrometer, accurate and compact, consists of flexibly supported mass and dial indicator fastened to end of thumb screw and supported by mass to measure amplitude. Reliable for frequencies up to 6,000 r.p.m.

when amplitude does not exceed 0.004 in., and at lower speeds for much higher amplitudes.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



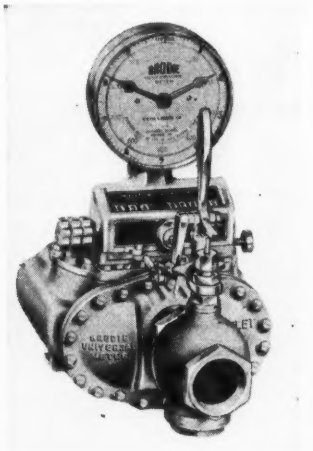
Resetting Counter

This Veeder-Root, high-speed resetting counter is of 5-figure locked-wheel type. Operates either direction. Reset to zero by single turn of wing nut. Will operate accurately at 8,000 counts per minute in direct-drive models, or to 2,000 counts per minute in revolution-type design. 4.09x1.44x1.295 in.—*Veeder-Root, Inc., Hartford, Conn.*



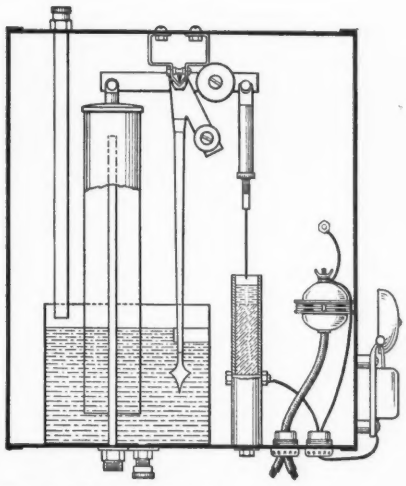
Escapement-Type Integrator

Total flow given on six-figure counter. Heart-shaped cam, geared to Warren synchronous motor at 2 r.p.m. By means of friction clutch motor also drives escape wheel and integrator counter at constant speed when pawl is not engaged. With pawl engaged with escape wheel, integrator counter is held stationary, but cam continues rotation. Position of roller-arm pivot varies only with changes in rate of flow. Right end of roller arm moves up and down under action of rotating cam, causing pawl-operating pin to engage and disengage pawl. Integrator total thus adjusted to rate of flow four times a minute.—*Bailey Meter Co., 1036 Ivanhoe Road, Cleveland, Ohio.*



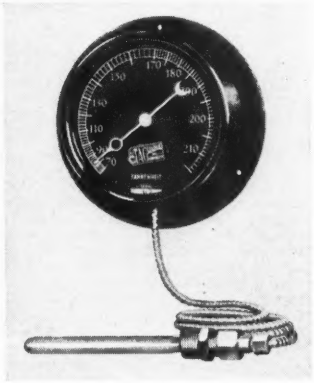
Quantrol-Equipped Meter

Automatically measures given quantities of fuel oil or gasoline. Vertical type has extra large dial. Set to quantity desired and outlet valve opened; shut-off automatic when metered quantity is dumped.—*R. N. Brodie Co., Inc., 967 61st St., Oakland, Calif.*



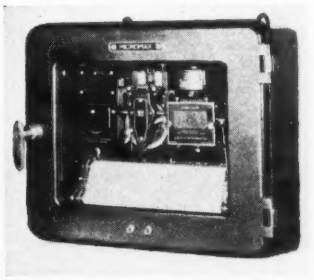
Draft Gage Alarm

Either straight-line or dial-type pointer draft gages from minus, plus or differential readings, and for either high- or low-draft alarm. Transformer for either 220 or 110 volts, dry cells for other than a.c. current. Electric contact rod suspended on gage beam is adjustable to ring bell at any scale point within variation not to exceed 0.01 in. Dial-type gage with alarm for low minus draft.—*Ellison Draft Gage Co., 214 W. Kinzie St., Chicago, Ill.*



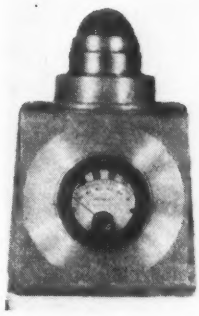
5-In. Dial Thermometer

Low-price. Element suited to commonly used vapor tension ranges between —40 and 335 deg. F. Indicating pointer actuated by bronze bellows. Bulletin 1050.—*C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.*



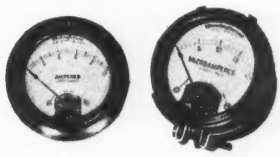
Multi-Purpose Case For Recorder

Dust-tight and vapor-tight when desired, this case can be supplied for mounting in any position. Switches for motor, lights and control circuit are operable externally and vapor-proof. Leads to recorder brought in through conduit connections or pothead.—*Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.*



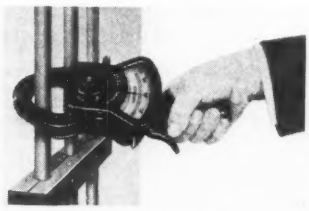
Sensitive-Cell Smoke Detector

Light from projector on one side of smoke passage falls on sensitive cell on opposite side, causing variations in cell electrical output. Current read on meter in percentages of light obscuration (having also Ringlemann points indicated); called "Smokgage." May be used to operate relay for flashing light when permissible density is exceeded (Smoklite) or for ringing bell (Smokbell). Smokgage-Smoklite shown calls operator's attention by signal lamp and affords gage for regulating burner to desired density.—*Ess Instrument Co., 30 Church St., New York, N. Y.*



Supersensitive Instruments

2 or 2⅞ in. in body diameter. Give full-scale deflection on one or two micro-watts. Lowest standard microammeter has scale 0.20 micro-amperes and coil resistance 2,100 ohms. Millivolt-meters have scale of 0-3 millivolts and resistance of about 9.1 ohms.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

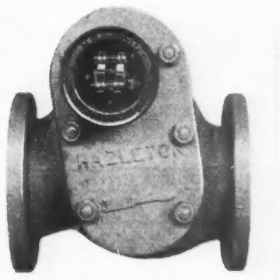


Tong-Type Testing Ammeter

"Tong-Test" ammeter permits measurements easily and quickly. Instrument of split electromagnet type, with no electrical windings; operable with one hand. Accommodates cables up to 1⅝ in. in diameter. Total weight 2¾ lb. Interchangeable elements permit scale range to be 50, 100, 150, 200 or 400 amp. Requires no shunts or ratio transformers.—*Columbia Electric Mfg. Co., 1293 East 53rd St., Cleveland.*

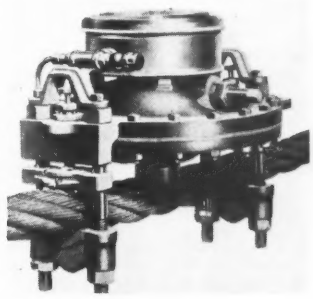
Square-Case Synchroscope

Synchroscope of moving iron-vane type added to Type H square switchboard units. Energy consumption of each circuit about four volt-amperes, making instrument usable with condenser bushing potential devices. Position indicators and 360 deg. scale power factor meters also. — *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



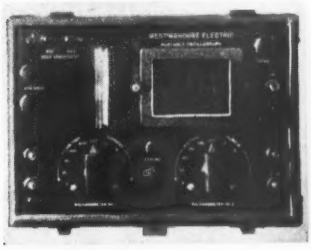
Check Valve With Mercoid Flow Switch

Type M check valve with Mercoid flow switch shuts down pump if it loses its prime. Switch, connected into low-voltage coil of motor starter is actuated by valve flap. Can be arranged for either horizontal or vertical mounting of valve.—*Barrett, Haentjens & Co., Hazleton, Pa.*



Tension Indicator

New feeler gage increases efficiency of Martin-Decker tension indicators. Gage incorporated in indicator itself underneath clamping device, determines exactly when instrument is in correct position. On heavy-duty indicator, micrometer deflection and saddle adjusters replace series of deflection plugs.—*Martin-Decker Corp., 3431-45 Cherry Ave., Long Beach, Calif.*



Portable Oscillograph

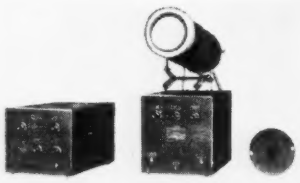
Uses new type optical system and galvanometer. Entirely self-contained and operated from 110-volt, 60-cycle circuit without auxiliary attachments. Compact.— *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

Depth Gage (Right)

"Tank-O-Meter" gage, Type V. 24 models for liquid depths from 12 to 675 in. Calibrated in depths, units of weight, or units of volume. Three different indicating fluids give scales of various lengths in proportion to depth to be measured.—*Uehling Instrument Co., 473 Getty Ave., Paterson, N. J.*

Dry-Type Pointer Draft Gages

Available in single and two-unit styles and for portable work and wall and flush mounting. 5x4x9 in. Scale length, 3 in. Graduations in 0.01 in. of water. Screw for setting pointer outside case. Standard ranges ½ to 1 in. water. Differential types for indicating resistance, gas or air flow. For forced-draft stokers, two-pointer gages with upper scale range of + 5 in. and lower scale + 0.2 to 0 to-0.3 in. water offered. Other ranges special.—*Hays Corp., Michigan City, Ind.*

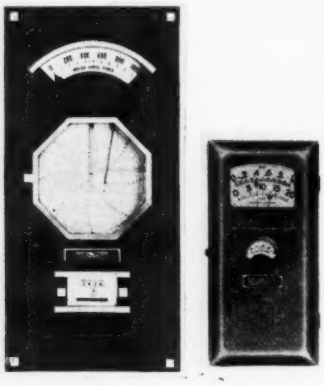


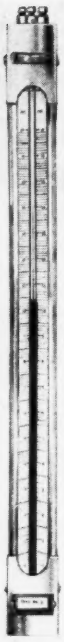
Cathode-Ray Oscillograph

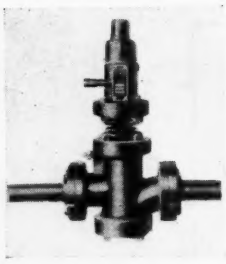
Type HG-10-B1 is low-price, quality instrument for study of recurring waves from power frequencies to several million cycles per sec. Portable. Requires only 200 watts, and operates on any 110 volt, 50 or 60-cycle source.—*General Electric Co., Schenectady, N. Y.*

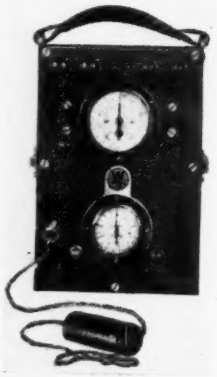
Improved Flow Meters

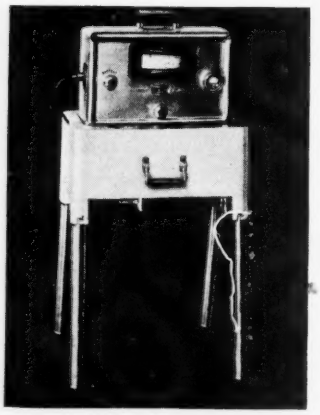
Same basic principles, but entire revamping of design, characterize new line. "Cartridge-sealed element," is new easily interchangeable actuating unit. Used on indicator, recorder, and integrator, which in new design extend above panel only 1 in. New boiler horsepower indicator, "CS-24," has 24-in. porcelain enamel dial. — *Republic Flow Meters Co., 2222 Diversey Pkway., Chicago, Ill.*











Combustible Gas Analyzer

Model RZA measures combustible components of gaseous mixtures continuously and automatically. Operates from 110- or 220-volts. Direct reading in per cent of combustible gases. Time lag less than 20 sec., and unit unaffected by room temperature and voltage changes. Operates on principle of combustibles burning catalytically along heated resistance wire, which forms one arm of wheatstone bridge.—*Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.*

Switchboard Instruments

Type E45 first-grade switchboard units are 5 in. across front flange. Type S30 are lower in cost, and 2⅞ in. across flange. Four standardized panels. Specials on order. Bulletin MS-1.—*Columbia Electric Mfg. Co., 1292 East 53rd St., Cleveland, Ohio.*

Automatic CO_2 Indicators and Recorders

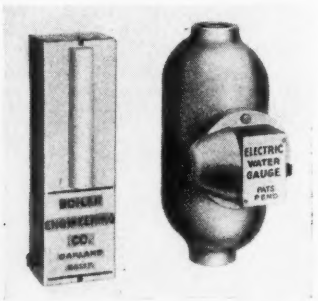
Used for CO_2 indication only; CO_2 and draft; CO_2 draft and flue gas temperature; or CO_2 and flue gas temperature; in flush, panel or wall-mounted types. Analyzer section may be placed up to 100 ft. from indicator case. Shown at left is indicator reading CO_2 content, flue gas temperature and amount of draft. — *Hays Corp., Michigan City, Ind.*

Area-Type Flow Meter

Body installed directly in pipe lines without seals or auxiliary piping. Meter-body of piston and sleeve type. Piston position measured by inductance bridge system, reading on evenly graduated scales. Range adjustable. Ranges in measuring water and similar flows from 0 to 150 g.p.h., to 0 to 2,000 g.p.h. maximum. Meter capacity less for fluids with lower specific gravities. — *Brown Instrument Co., 4490 Wayne Ave., Philadelphia, Pa.*

Portable Stroboscopic Meter Standard

This new standard can be used whether meter does or does not have provisions for stroboscopic testing, and whether meter is to be calibrated or tested to determine its "as found" accuracy. Two compartments, one containing meter complete and other containing power unit and amplifier. — *Westinghouse Electric & Mfg. Co., Newark, N. J.*



Electric Water Gage

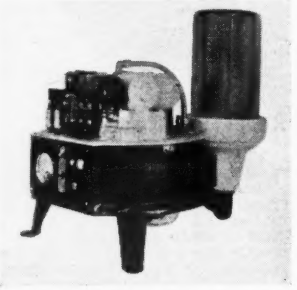
"Bo-En-Co" records electrically, at any desired point, water level in steam boilers, pressure tanks or other containers. Indicator tube visible at 200 ft. Bell sounds at 3-in. change of level. Indicator has lighted column in various colors.—*Boiler Engrg. Co., Engineers Exchange Bldg., 715-19 Peralta St., Oakland, Calif.*

Square Switchboard Instruments (Photo Below)

Type K, rectangular, flush mounted and supplied with illumination. New method of attaching front cover eliminates screws from front plate. Occupied panel area, 4x4½ in. Scale length, 3½ in. Units available in volts, amperes, watts, power factor, frequency, reactive volt amperes, and radio-frequency amperes. — *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

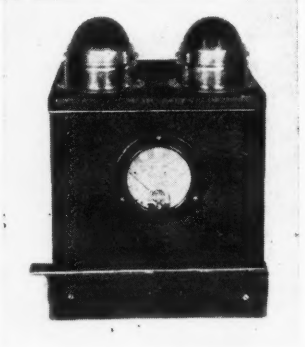
Dial-Type Indicator

No. 22 MJL dial-type indicator or gage provides reasonably priced instrument for accurate indication of rates of flow and differentials or may be used as tank level indicator. Mechanically-operated, direct-reading type actuated by metal bellows. Large dial with large figures. Dial calibrations in inches differential g.p.m. of flow, or other direct readings. Outside zeroing adjustment. 250 lb. per sq.in. maximum working pressure and differential pressures from 5 in. of mercury to 25 lb. Accuracy within 1½ per cent.—*Morey & Jones, Ltd., 922 S. Hemlock St., Los Angeles, Calif.*



Automatic Water-Hardness Tester

Hardimeter uses photo-electric cell and sounds alarm if hardness exceeds specified figure. Extracts sample periodically (period adjustable 2 min. to 20). Automatic control. Two models, one for use where color and turbidity are fairly constant, other where either varies appreciably. — *Elgin Softener Corp., Elgin, Ill.*

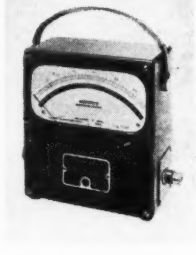


Combustion Indicator

Uses photoelectric cell to record very small changes in gas density. Meter gives continuous indication of haze. Visible or audible signals can be provided. In instrument shown red light indicates smoke, green light excess air. — *Ess Instrument Co., 30 Church St., New York, N. Y.*

Portable Instruments

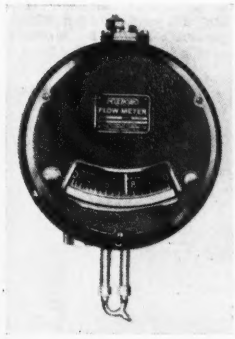
"Steel-Six" d.c. and a.c. portable instruments, have steel cases about 6 in. sq. Unusually long scales (5⅝ in.) high accuracy, open and lighted dials, fusing when desired. Available in complete line. Type HTD for direct current and HTA for alternating current. Accuracy is ½ of 1 per cent of for ammeters, volt-meters and single-phase watt-meters, and 1 per cent of full scale for other instruments. —*Roller-Smith Co., 233 Broadway, New York, N. Y.*

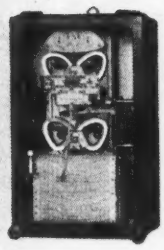


Miscellaneous Equipment

Electric-Contact Gages For Draft, Pressure

Dry-type actuating units used in these compact electric gages for draft, pressure and differential draft or pressure in ranges from 0.1 in. to 100 in. water. High- or low-contact service or both. Closed mercury switches or open contacts; 3-in. scale. Case air-tight for differential pressure or draft service.—*The Hays Corp., P. O. Box 299, Michigan City, Ind.*





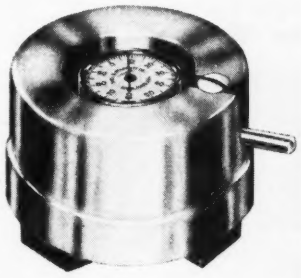
Indicating Flow Meter

Gives continuous check on operating conditions. Compact case and wide scale, reading per cent of total flow. Beneath graduated scale is white space on which reference notations of actual flow may be marked. May be equipped with scale giving direct flow readings. — *Foxboro Co., Foxboro, Mass.*

Watt-Hour Demand Meters

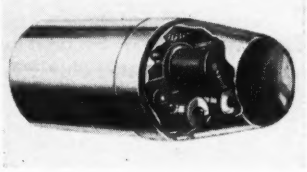
(cut above)

Type DG-1 combines watthour meter and recording demand meter. Demand mechanism of "block-interval" type, recording on strip-chart. Same characteristics as Type 1-16, including high torque and complete temperature compensation for all power-factors.—*General Electric Co., Schenectady, N. Y.*



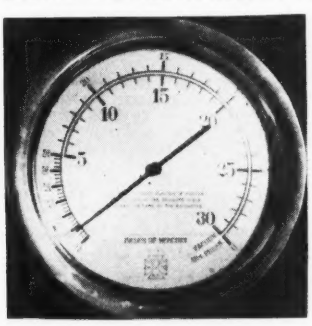
Vibrometer

Starrett vibrometer particularly useful for checking balance of units revolving at high speeds.—*The L. S. Starrett Co., Athol, Mass.*



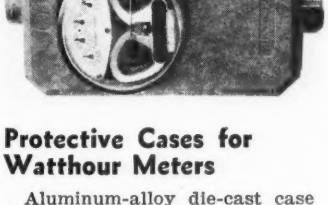
Radiation Pyrometer

Illustrated is radiation tube of "Pyro" pyrometer, compact, self-contained unit with all parts inclosed. Thermocouple bulb develops energy by having focused on it, through a quartz lens, radiant heat and light rays from body to be measured. Can be used with any standard indicator or recorder. Standard tubes develop 12 millivolts with a time lag of 12 sec., in ranges from 1,300-2,200 deg. F., to 1,800-3,600 deg. F. Supersensitive tubes in two types; *A* which develops 20 millivolts starting at 750-1,500 deg. F., and up, to 1,800-3,600 deg. F., and *B* developing 60 millivolts with time lag of approximately 2 sec., in ranges from 1,400-2,400 deg. F., to 1,600-3,600 deg. F. Cast-aluminum water-cooled jacket for tube if needed.—*Pyrometer Instrument Co., 103 Lafayette St., New York, N. Y.*



Compensated Vacuum Gage

Because of high vacuum at which steam turbines operate, a close check must be had on vacuum if turbines are to operate at maximum efficiency. This requires a vacuum gage that reads to high accuracy. Compensated for both temperature and barometric pressures. Bearing friction very low. To obtain greater reading accuracy, pointer travels nearly 360 deg. Developed by Comdr. C. J. Odend'hal, U. S. Coast Survey, and marketed by: — *United States Gauge Co., 44 Beaver St., New York, N. Y.*



Protective Cases for Watthour Meters

Aluminum-alloy die-cast case for protection of single-phase watthour meters. Modernistic shape. Between meter cover and box cover thick rubber gasket under compression. — *General Electric Co., Schenectady, N. Y.*

Welding Spectacles

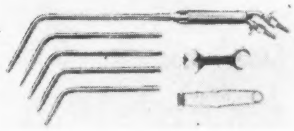
Oxweld No. 15 spectacles have lenses in canvas-bakelite frames. New Type AA lenses are 50 mm. wide. Bows covered with insulating material. Snap device permits lens changes. Lens, flat ground and polished, in light, medium and dark green. —*Linde Air Products Co., 30 East 42nd St., New York, N. Y.*

Electric Arc-Welder

Redesigned Hobart welder has 60 per cent more capacity and is fitted for handling both coated and plain rods. Waterproof. Remote control permits operator to weld 50 to 100 ft. away.—*Hobart Bros. Co., Troy, Ohio.*

Heavy-Plate Electric Welding

Murex straight-gap welding does away with "veeing" plate edges. Greater welding speed, cost reduction, claimed. Also Murex heavy mineral-coated electrodes, known as Universal, for use on mild steel in flat, vertical or overhead work.—*Metal & Thermit Corp., 120 Broadway, New York, N. Y.*



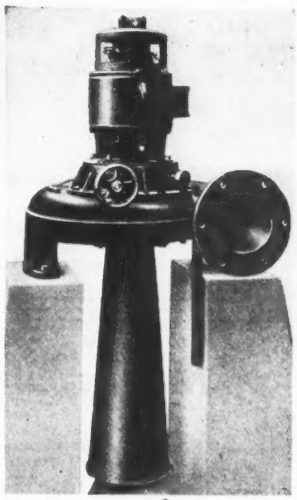
Welding Torch

"Purox" No. 28 welding torch handles heavy-duty work. Ten one-piece, 60-deg., gooseneck tips available. Adjustment for overhead or vertical welding without change in normal grip. Tips 6, 8, 10, 12 and 14 furnished.

Improvement in Oxweld Type CM-17 cutting attachment whereby heating oxygen throttle can be used as oxygen shut-off valve for temporary stops in cutting.—*Linde Air Products Co., 30 E. 42nd St., New York, N. Y.*

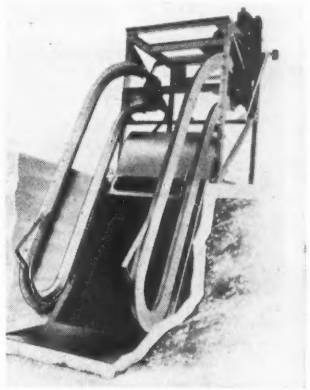
Aluminum Welding Flux

Replaces two fluxes, one for welding pure aluminum, other for welding aluminum alloys. Does all other two did and improves quality. Packed in ¼-lb. jars.—*Linde Air Products Co., 30 East 42nd St., New York, N. Y.*



Small Standby Hydro-Electric Unit

Turbines of vertical-shaft type with spiral cases, movable gates, but may be had with horizontal shaft. Generators standard, 125- or 250-volt, compound-wound, constant-voltage type. Manual or governor adjustment. Water turbines, without generator, also offered for driving machinery where electric motors would be hazardous, and water-works service for chlorinating service. Capacities ½-80 hp.—*J. M. Voith Co., Inc., 723 Chrysler Bldg., New York, N. Y.*

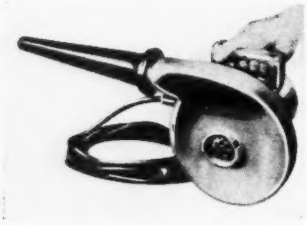


Self-Cleaning Bar Screen

Automatic, this screen has clear opening from side to side in submerged portion and has no sprockets or shafts at bottom of channel; chain floats around large-radius curves in guides. Scraper enters channel back of accumulated refuse. Teeth drag forward over bottom and up screen. Rake teeth pass entirely through screen to top, then engage automatic wiper. Control mechanism provides continuous or intermittent operation at intervals from 2 sec. to 1 hr. Differential float control can be furnished if desired. Shear pins permit release of mechanism in emergency. — *Jeffrey Mfg. Co., Columbus, Ohio.*

Nickel-Clad Steel Sheets

Thin-gage hot-rolled (No. 16 up) or cold-rolled (No. 32 gage up) with bright and polished finish. Also pure nickel-clad wire. Bulletin.—*H. Boker & Co., Inc., 103 Duane St., New York City.*



Portable Electric Blower

Tornado Model 10 is light and small. Uses 1-hp. ball bearing motor, which, with special fan, gives 46½-in. water lift.—*Breuer Electric Mfg. Co., 852 Blackhawk St., Chicago, Ill.*

High-Temperature Spring Material

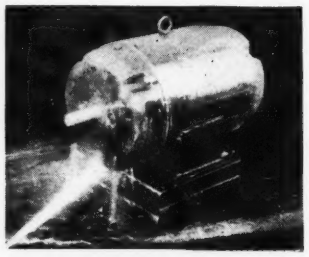
Springs of Inconel high-nickel stainless alloy (80% nickel, 14% chromium, 6% iron) retain load-carrying capacity to 700 deg. F. — *International Nickel Co., 67 Wall St. N. Y. C.*

Mechanical Tube Cleaner

"Drill-Drive" is straight-line, tubular, telescoping driving device with automatic clutch using latest type Tubrush and ½-in. or larger electric drill. Adaptable for tubes 2 in. or larger in lengths up to 20 ft. — *Tube Cleaning & Equipment Co., 1 Court St., Boston, Mass.*

Transparent-Cup Goggle

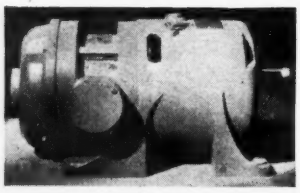
Cups of transparent material Sturdy, spark-proof light. Can be worn over spectacles.—*Wilson Products, Inc., Reading, Pa*



Splash-Proof Motor

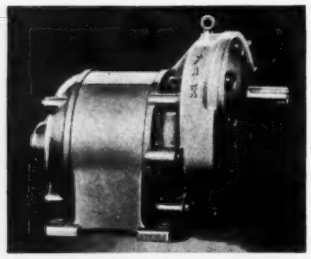
Baffles in air ducts remove spray from entering air. Simply standard induction motor using special bearing brackets. 1 to 200 hp. as squirrel-cage induction motors. Also across-the-line start motors up to 200 hp. and unity or 80 per cent leading power-factor induction motors in all sizes.—*Ideal Electric & Mfg. Co., Mansfield, Ohio.*

Motors, Electrical and Elevator Equipment



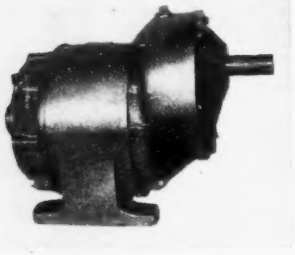
Gearmotors

Type S, rated ¾ hp. and up, combines motor and speed reducer. Rotating cartridge-type gear unit can be removed without disturbing alignment and provides 4 to 8 output-shaft positions. Ratio can be changed readily by user. Oil height checked by bayonet-type oil gage. Wide range of ratios with both a.c. and d.c. motors. —*Reliance Electric & Engineering Co., 1042-109 Ivanhoe Road, Cleveland, Ohio.*



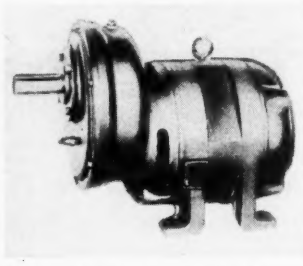
Geared-Head Motoreducer

Makes possible use of high-speed motors and provides any speed from 1/9 to about 2½ times motor speed. Single-pair gear train. Low-speed shaft on Timken roller bearings. 18 standard reduction ratios. Bulletin 261.—*Falk Corp., Milwaukee, Wis.*



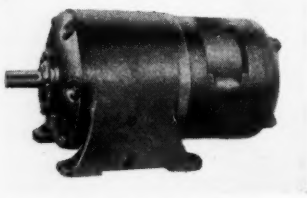
Geared-Head Motor

Type S gearmotors are scarcely longer over-all than motors. Drives from ½ to 75 hp. and for 1,550 to 232 r.p.m. Fourteen reductions, 1-12 to 1-5.1. Changes in output speeds made readily and evenly. Helical gears, fully enclosed, run in oil bath.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



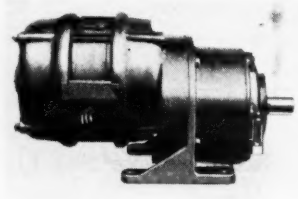
Motorized Speed Reducer

From ½ to 20 hp., and in wide range of ratios and speeds. Continuous-tooth herringbone gears mounted on anti-friction bearings, running in oil. — *D. O. James Mfg. Co., 1114 W. Monroe St., Chicago, Ill.*



Motor Reduction Unit

Standard round-frame type motor mounted directly on gear reducer housing. Helical gears used. Standard speeds 3.02 to 380 r.p.m. but lower speeds can be provided; 6.08 r.p.m. obtained with 1,750-r.p.m. motor. Lubrication automatic. Standard units for floor mounting, but others available. Any motor.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*



Geared Motors

Gear reduction unit mounted directly on motor shaft. All gear ratios 2.09-1 up to 376-1, giving output speeds of 861 to 4.7 r.p.m. using 1,800-r.p.m. motor. Ratios up to 6-1 use reducers with single-stage helical gears. Those up to 24.5-1 use two-stage helical-gear reducer, and above 30-1 use one stage helical and one stage heliocentric. Units using heliocentric gears (illustrated) have motor hung on reducer. Others have reducer hung on motor. All horsepowers from ¾ to 20. Either open or inclosed-type motors for 2- or 3-phase a.c. or d.c. Two- three- or four-speed types.—*Ideal Electric & Mfg. Co., Mansfield, Ohio.*

Synchronous Motors

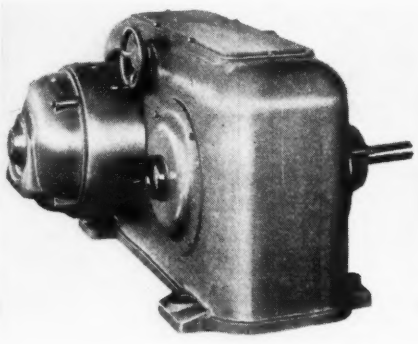
Small and medium-capacity. Installed as easily as ordinary induction motors. Self-synchronizing and separately excited. Leading power factor of 0.9 at full load. Amortisseur windings for high starting torque; ½ hp. at 1,800 r.p.m. up to 40 hp. at 900 r.p.m. Bulletin S-1.—*Columbia Electric Mfg. Co., 1292 East 53rd St., Cleveland, Ohio.*

Breaker with Oil-Filled Bushings

Rated 15, 25, and 34.5 kv., this line of circuit breakers is equipped with oil-filled bushings of a new type. By utilizing oil-blast principle of circuit interruption, breakers operate in eight cycles. Designated Type FHKO-339 for indoor and outdoor service, and have interrupting ratings from 500,000 to 1,500,000 kva.—*General Electric Co., Schenectady, N. Y.*

Variable-Speed Motor

Vari - speed motors have heavy, wide, high-speed V-belt connecting variable - diameter pulleys on fixed parallel shafts. Pulley diameters varied inversely by small handwheel. "Slo-speed" gears can be built integral with output shaft to provide single or double reductions for slow speeds down to 5 r.p.m. Speeds up to 15,000 r.p.m. also. — *Sterling Electric Motors, Inc., Telegraph Rd. at Atlantic Blvd., Los Angeles, Calif.*



Disk Thermostat for Motor

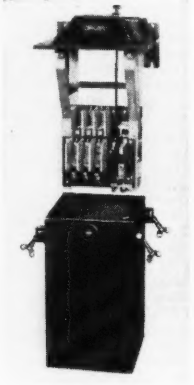
Opens circuit when motor gets too hot, closes it again after motor cools. Will handle up to 15 amp. at 110 volts. Also can be used on large motors to operate protective relay. — *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

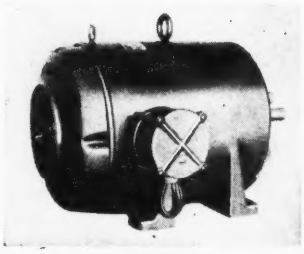
Collector-Ring Grinder

"Luft Model" grinder trues collector rings while they run at normal operating speed. Restores rotaries to about 50 per cent capacity in a few minutes. Head of unit removable and has three different types of supports. Units for iron, steel, bronze and brass ring grinding and for following-size resurfacer tools: 2x2x8-in., 2x1x8-2x1x8-in. — *Ideal Commutator Dresser Co., Sycamore, Ill.*

Explosion-Proof Switch

CR 7008 oil-immersed combination switch for use in Class 1, Group D hazardous gas locations. Three sizes for motors up to 50 hp. at 440 volts. Essentially three parts with all connections 6 in. below surface of oil in welded tank.—*General Electric Co., Schenectady, N. Y.*



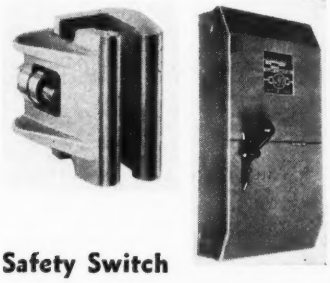


Totally-Enclosed Fan-Cooled Motor

Same sizes as ordinary open motors of same ratings, these totally enclosed fan-cooled units provide full protection. All sizes from 1 to 200 hp. as squirrel-cage induction motors for all classifications of torque and in-rush requirements and with 1, 2, 3 or 4 speeds. Also as across-the-line start motors up to 200 hp. and for power-factor correction.—*Ideal Electric & Mfg. Co., Mansfield, Ohio.*

Fuse Clip Clamp

Ideal clamps for knife-blade fuses provide proper alignment and positive contact between fuse knife and switch fuse blocks. Easy to apply; only two sizes from 100 to 1,200 amp. Clamp is slipped over switch fuse blocks after fuse is in place and fastened by lever action.—*Ideal Commutator Dresser Co., Sycamore, Ill.*

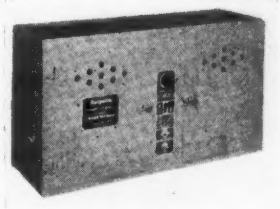


Safety Switch

Type A quick make-quick break, for severe duty, extremely compact. Semi-floating, double-break. V-blades, V-stationary contacts backed up with steel springs, individual barriers asbestos, all mounted on base.—*Electric Controller & Mfg. Co., 2696 E. 79th St., Cleveland, Ohio.*

Neon Glow Lamps

Four sizes, ½, 1, 2 watts for 110-120 volts and 1 watt, 100-550 volts. First three have resistance built into base and fit medium-screw sockets. Smallest size for a.c. only; others either a.c. or d.c. Last type uses resistance in series and fits candelabra screw socket. — *Westinghouse Lamp Co., Bloomfield, N. J.*



Emergency Lighting System

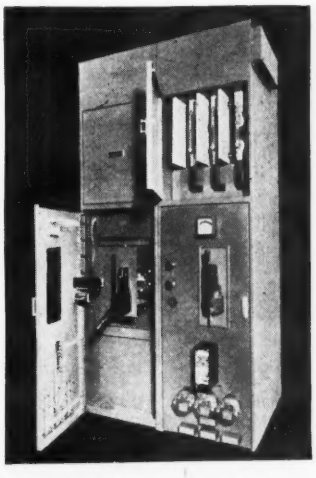
"Keepalite" self-contained system supplies separate source of current to its own high-efficiency, low-voltage lamps. Exide battery, automatic relay, battery charger, switches and signal, assembled in compact metal case. Battery trickle charged. Unit is 2 ft. 9 in. long, 10 in. deep and 16 in. high.—*Electric Storage Battery Co., Allegheny Ave. & 19th St., Philadelphia, Pa.*

Insulation Tester

Weighing only 3 lb., "Megger" midget insulation tester is 5⅜x4x2⅜ in., and incorporates ohmmeter direct reading like a voltmeter, and d.c. hand generator supplying testing current at 500 volts. Scale reads as high as 20 megohms.—*James G. Biddle Co., 1121 Arch St., Philadelphia, Pa.*

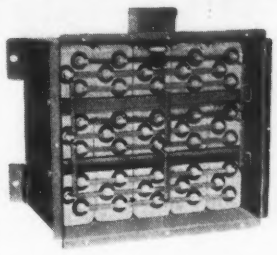
Neon Lamp for Signal Indicators

Type N-1 Neon glow lamp has G-6 bulb and candelabra screw base. No ballast resistance inside base. External resistors can be placed in series with lamp socket. Lamp begins to glow at 85 volts and 110 volts d.c. Only one electrode glows on d.c. circuits, making it possible to use lamp as polarity indicator. — *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



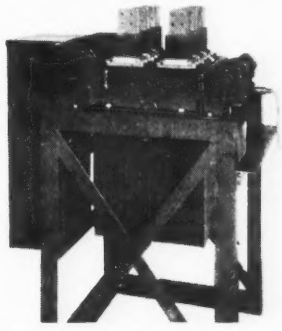
Steel-Enclosed Cubicle

Standardized 7.5-kv. cubicles. Manually solenoid or motor-operated oil circuit breakers are trip free, and operating mechanism interlocks with hinged door of disconnecting switch compartment. Ready connection to other units. Relays, meters, instruments and control switches attached to hinged doors for ease in wiring. — *Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.*



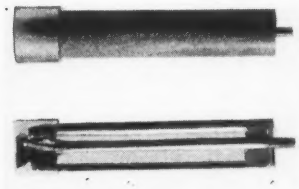
Capacitor for Power-Factor Correction

Assembly of hermetically sealed can units, each heat-treated and impregnated with oil under vacuum. Fuses sealed in can under oil. Rack-type units in sizes over 30 kva. with weatherproof housing or steel screen enclosure. All voltages up to 4,600 and any frequency and phase arrangement; any size.—*Ideal Electric & Mfg. Co., Mansfield, Ohio.*



Oil Circuit Breaker

5-kv., 3,000-amp., 50,000-kva., 3-pole, non-oil throwing type indoor form oil circuit breaker. Welded square tank. Straight-line motion mechanism operates under heavy Everdur domed tank head, eliminating magnetic heating. Terminals and bushings copper bars with wrapped impregnated bakelized paper.—*Delta-Star Electric Co., 2400 Block, Fulton St., Chicago, Ill.*

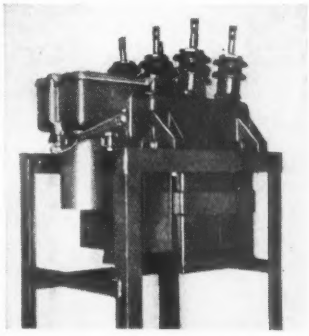


Boric Acid Power Fuse

De-ion power fuse for outdoor or indoor service. Renewable fuse elements in standard current steps from 5 to 200 amp. Interrupting capacity varies with voltage ratings only. On basis of 3-phase power, three standard voltage ratings of 7, 5, 15 and 23 kv. have interrupting capacities of 325,000, 500,000 and 600,000 kva.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

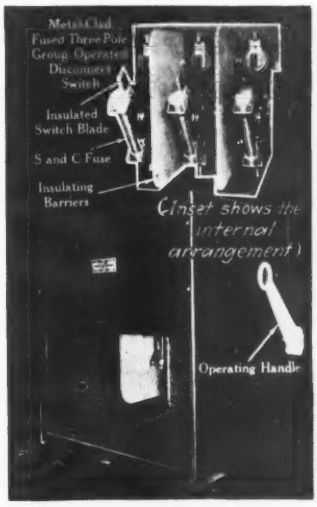
Air Circuit Breaker

Manually and electrically operated, trip-free, multi-pole air circuit breaker. Type AB-2 metal-inclosed with or without pull box, metal-inclosed with pull box and disconnecting devices or mounted in dead-front and metal-inclosed switchboards. Ratings 15-400 amp., 250 volts d.c., and 600 volts a.c. High interrupting capacity. — *General Electric Co., Schenectady, N. Y.*



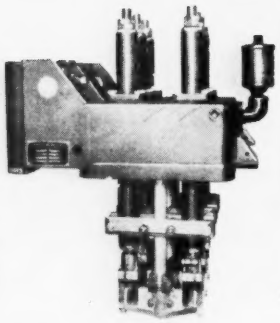
Automatic Reclosing Breaker

Self-contained reclosing equipment for lightly loaded feeders in Type FO-22 breaker, 7,500 volts, with 50,000-kva. interrupting capacity rating on 2-OCO duty cycle. Operates over a CO 1 sec., OCO 2.8 sec., OCO lockout duty cycle. Breaker solenoid-operated from a.-c. source by Rectox in distribution transformer tank. Operating transformer and Rectox can be mounted in same tank. Breaker tripped by series coils in breaker tank. — *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



Metal-Clad Fused Switch

For service up to 15 kv. Safe, convenient and easily installed 3-pole, group-operated switch for industrial plant service. Three switch blades carrying fuses are interlocked and simultaneously opened and closed by handle.—*Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.*



Oil Circuit Breaker

Rectangular-tank Type CR-30AT, 15-kv., 600-amp., 3-pole breaker with interrupting capacity of 50,000 kva. at rated voltage. Fabricated steel head gridded on inside. Self-contained shock absorbers. Multi-part oil retractor separates oil from gases during arc extinction.—*Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.*

Refractory-Protected Mercury Switch

Nominal ratings 3 to 50 amp., single-pole, single-throw, for either a.c. or d.c. Contact made by impact between two pools of mercury within refractory chamber encased in heavy glass walls. Inert-gas atmosphere.—*Westinghouse Lamp Co., Bloomfield, N. J.*

Small-Diameter Motor

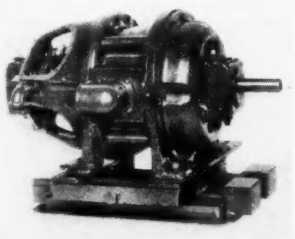
100-hp., 1,760-r.p.m., 60-cycle, 3-phase, enclosed, pipe-ventilated, horizontal, ball-bearing, squirrel-cage motor has diameter less than 12 in. Shaft center to flat on motor top, 5 $\frac{7}{16}$ in. Separate motor-driven blower.—*Louis Allis Co., Milwaukee, Wis.*

Photo-Electric Relay

Uses Visitron F2 photo-electric cell which operates without external source of voltage and without amplification. Unit, called FSE, is housed with auxiliary electromagnetic relay in compact cast aluminum case 6$\frac{1}{4}$x5$\frac{1}{4}$x4 in. Cells, auxiliary relays or the two relays in combination can be supplied assembled or individually.—*G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, Ill.*

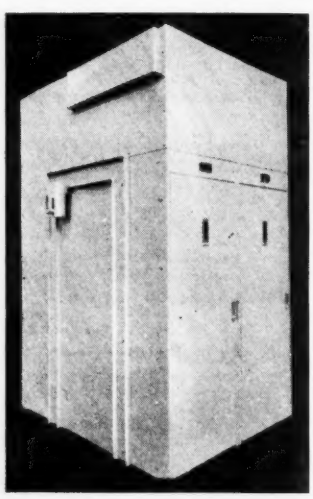
Rotary Pressure Switch

Heavy-duty, for control of single or multiple pumps, air compressors, electric valves, alarms or signals. Principle that of springless scale. Can make or break up to six circuits in any desired sequence. Easily set while in operation. Standard capacities, 0-10, 50, 100 and 200 lb.—*Water Level Controls Co., 765 Hampden Ave., St. Paul, Minn.*



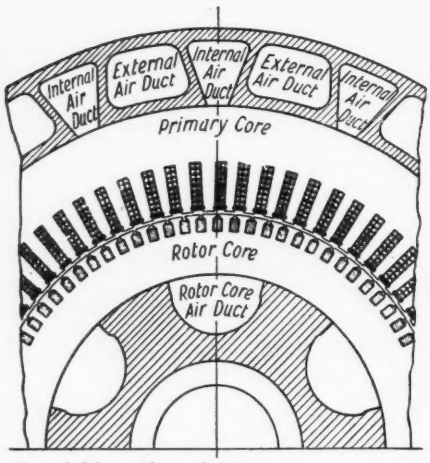
Sound-Isolating Motor Base

Floating members suspended on special material. Motor on standard sliding base, and belt tension and motor alignment maintained in usual manner. Bases for following motor ratings and speeds: Polyphase induction motors of 1 to 50 hp., 900 r.p.m.; $\frac{3}{4}$ to 30 hp., 1,200 r.p.m.; 1 to 3 hp., 1,800 r.p.m. Single-phase motors of $\frac{1}{4}$ to 2 hp., 900 r.p.m.; $\frac{1}{3}$ to 2 hp., 1,200 r.p.m.; 1 to 5 hp., 1,800 r.p.m.—*General Electric Co., Schenectady, N. Y.*



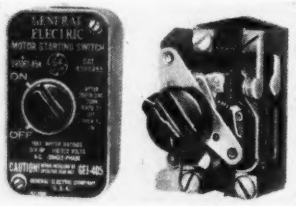
Metal-Clad Switchgear

Compact, totally enclosed switchgear, assembled at factory. Voltages up to 7.5 kv. Oil circuit breaker, relays, plug-type disconnect switches, insulated busses, wiring cable terminals, etc. Unit 10 ft. high, 2$\frac{3}{4}$ ft. wide and 7 ft. deep.—*Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.*



Dual-Ventilated Motors

This newly developed system makes possible enclosed motors up to 200 hp. with mounting dimensions comparable to those of open types. Frame contains two sets of ducts, as shown. Internal and external air circulated by fans through paths which cause rapid transfer of heat from internal air to frame and thence to external air. Double-end ventilation is used on larger machines.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

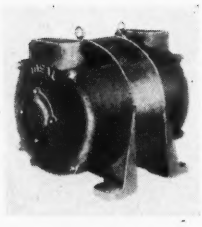


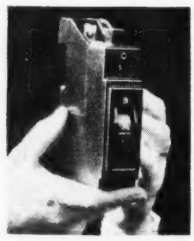
Starting Switch for Fractional-Horsepower Motors

Small, hand-operated starting switch, (CR 1061) for use with either single-phase a.-c., or d.-c. fractional-horsepower motors. A.-C. switch in single- and double-pole forms. Complete overload protection, positive snap-action mechanism trip-free on overload, compact construction. All molded parts Textolite; contact tips pure silver. Tested and listed by Underwriters Laboratories.—*General Electric Co., Schenectady, N. Y.*

Portable Lighting Plant

1- or 2-cyl. gasoline engine direct coupled to compound-wound continuous generator. Pushbutton or manual starting. Capacities 400 watts to 3 kw., generating 35- or 120-volt d.c. Greater capacities by 4- and 6-cyl. gasoline-generator sets with range 1$\frac{1}{2}$ to 60 kw. Also diesel sets in 35- and 50-kw. units.—*Electrical Division, Harnischfeger Corp., Milwaukee.*





Small Circuit Breakers

Type AF-1 breakers rated up to 600 volts and 600 amp. Arc occurs within closed metal chamber to interrupt circuit in 0.008 sec. Breakers trip-free from operating handle. On and off positions clearly marked. Overload tripping initiated through bi-metallic thermal strip.—*General Electric Co., Schenectady, N. Y.*

Pipe-Ventilated Motor

(Photo on top)

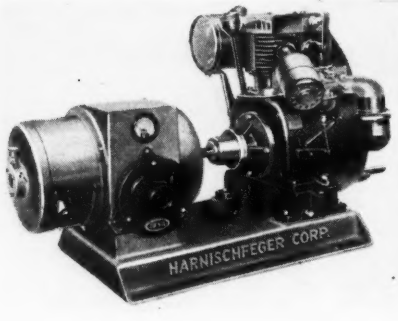
For unusually severe service exposed to excessive humidity, high temperature, abrasive particles, heavy dust and corrosive fumes. All torque and inrush classifications for both squirrel-cage and slip-ring induction motors, 1 to 200 hp., including across-the-line start motors. Unity and leading power factor induction motors also. Motors for two- or three-phase, 25, 30, 50 or 60 cycle-current, and up to 2,300 volts. Also, two-, three- or four-speed.—*Ideal Electric & Mfg. Co., Mansfield, Ohio.*

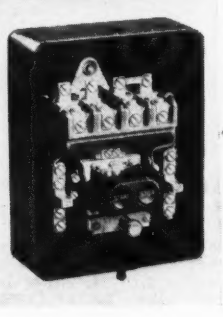
Submersible Combination Breaker and Switch

Inclosed in a submersible housing. Both circuit breaker and disconnecting switch have manual operating levers so interlocked that switch cannot be operated when breaker is closed, nor can breaker be closed when switch is open. Breaker can be equipped for electrical operation. Ratings up to and including 15,000 volts, 2,000 amp.—*General Electric Co., Schenectady, N. Y.*

Automatic Across-the-Line Switch

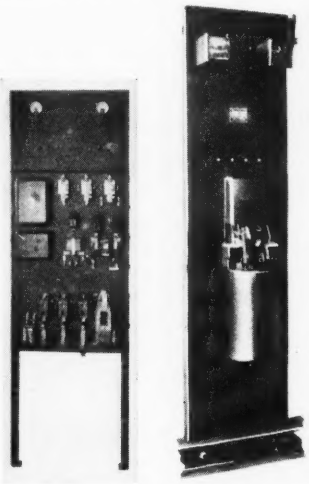
Rated at 5-hp., 220 volts; 7$\frac{1}{2}$-hp., 440 and 550 volts for polyphase motors, and up to 1$\frac{1}{2}$-hp., 110 volts; 3-hp., 220 volts for single-phase, self-starting motors, this solenoid-operated, across-the-line starting switch is made in three forms.—*Allen Bradley Co., 1311 S. First St., Milwaukee, Wis.*





Reclosing Device for Oil Circuit Breakers

Inexpensive, direct - acting Type SM will reclose an oil circuit breaker one, two or three consecutive times, with equal time intervals between reclosures, when breaker is tripped by overload. If overload exists after last reclosure, breaker remains locked open and must be closed manually. Available with both solenoid and motor-operated breakers.—*General Electric Co., Schenectady, N. Y.*

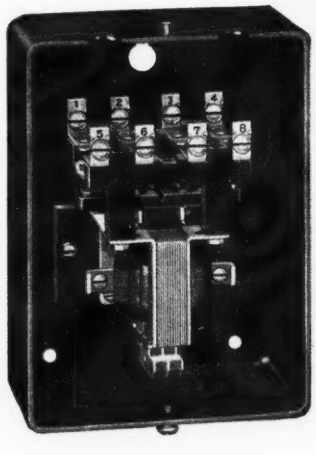


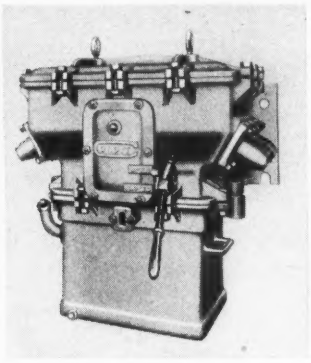
Controllers for Synchronous Motors

All standard lines of G.E. synchronous-motor control have been superseded by new. Included are relays for automatically applying and removing field excitation and for protecting stator and amortisseur windings under all operating conditions. For automatically applying field excitation when motor reaches predetermined speed near synchronism, new slip-frequency field-application relay is provided. Field can be applied at any predetermined speed from 92 to 99 per cent of synchronism. Unit also provided with power-factor field removal relay, which automatically removes field excitation when motor drops out of synchronism. Telechron motor-operated timing relay initiates transfer from starting to running connections on reduced-voltage and part-winding controllers.—*General Electric Co., Schenectady, N. Y.*

Solenoid-Operated Contactors

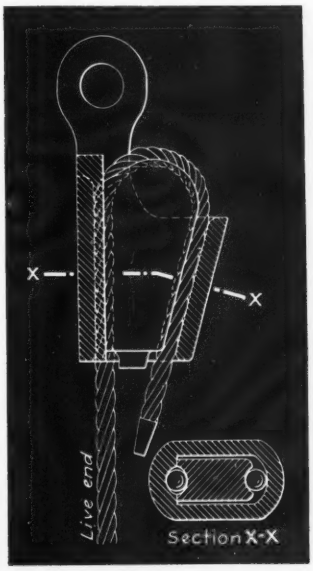
Bulletin 700 a.c. contactors with or without inclosing cabinets, single- or multiple-pole with silver-to-silver contacts up to 8-pole unit for 2-wire control. Compact, and contacts supported on self contained insulating cross pieces. Operating coils for any voltage—6, 12, 24, 110 and 220 standard. Furnished with standard 2- and 3-wire control and built-in transformers. Other models with resistors for thermostat control. Special line of mechanically-held contactors — no current flows except when contactor is closed or opened. Ratings 5 to 30 amp.—*Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis.*





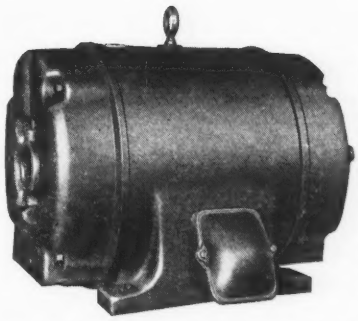
Subway Oil Switch

Type EM-50, water-tight construction, for wall mounting in subway or manhole, etc. Furnished with single - conductor cable sleeves or multi-conductor cable bell. Insulation characteristics considerably above A.I.E.E. requirements. Furnished manually operated, non-automatic 2-, 3- and 4-pole single throw, and 2- and 3-pole double throw, with or without interlocks, for 200 and 400 amp. at 7,500 volts.—*Condit Electrical Mfg. Corp., Hyde Park, Boston, Mass.*



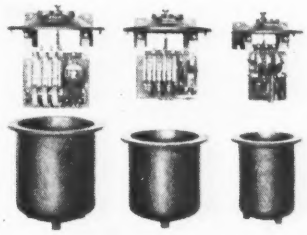
Wedge Socket for Wire Rope

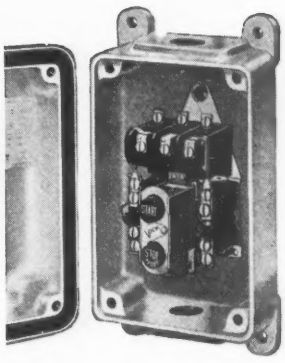
Will develop more than 90 per cent of ultimate rope strength. Known as "No-pinch" type. Only a predetermined amount of pressure can be applied to pull end of rope. If rope tension increases sufficiently to pull wedge further into socket, machined bearing surfaces in contact transfer additional pressure to dead side of rope, which carries smaller part of load. Available for ropes from ⅜- to 2⅜-in. in diameter.—*John A. Roebling's Sons Co., Trenton, N. J.*



Splash-Proof Motors

One to 30 hp. indoor or outdoor installations. Frame end brackets grey iron castings. One-way ventilation provided by intake and outlet openings in lower section of end brackets. Bearing bracket fitted to frame by long-contact sealed fit. Cartridge-type, grease-lubricated ball bearings.—*Century Electric Co., St. Louis, Mo.*





Hand-Operated Starter

Splash-proof, for motors up to 3 hp., 110 volts; 5 hp., 220 volts; and 7½ hp., 440-550 volts.—*Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis.*

Full-Voltage Magnetic Switch

Full-voltage magnetic switches for industrial control equipment. Class I Group D hazardous locations. Weatherproof; suitable for use in corrosive atmospheres. Standard magnetic switches with special operating coils and special contact tips for operation under oil, and an oil-immersed temperature overload relay. Inclosure is explosion - proof. Switch and relay, fastened to top cover. Relay reset by button through top cover.—*General Electric Co., Schenectady, N. Y.*

Oil Filters, Purifiers, Lubricators, Lubricants

Turbine Oil

Guaranteed to last as long as turbine. "Nonpareil" does not react with air and does not change in use.—*Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago.*

Leaded Lubricant

"Bestolife" has pure metallic lead in finely divided particles in lubricant vehicle. Percentage of lead ranges from 10 to 65. Withstands temperatures to 430 deg.—*Armite Laboratories, 1450 East 61st St., Los Angeles, Calif.*

Loose-Pulley Oiler

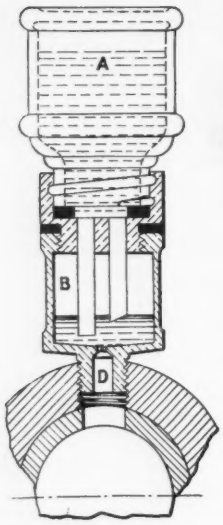
"Vosta" oiler consists of glass body and bronze base in which tube is mounted extending to near top of bottle. Feeding governed by thermal principle—periodic expansion and contraction of air within reservoir due to temperature changes. Booklet F-524.—*Lunkenheimer Co., Cincinnati, Ohio.*

Re-Refining Equipment

Fabriform refinery, by proper heat application and steam agitation, produces controlled distillation. Oil-burner type unit uses diluents recovered from refinery, running on own waste material. All-welded construction in accordance with A.S.M.E. Boiler Code, built-in initial heater and condenser, quick-acting filter chamber release for cleaning, pressure filter, no moving parts. Two models, R-10, capacity 10 to 15 g.p.h.; R-20, capacity 20 to 25 g.p.h.—*Welded Products Co., Los Angeles, Calif.*

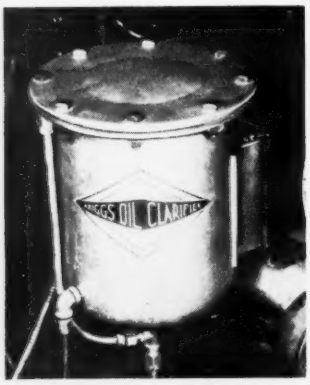
Constant Level Oil Control

"Alvor" maintains oil level automatically in ring-oiled or anti-friction bearings. Operates on liquid-seal principle. Adjusting collar allows ⅛-in. vertical adjustment to alter oil level in bearing. Folder F-595.—*The Lunkerheimer Co., Cincinnati, Ohio.*



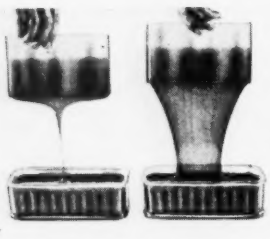
Automatic Bearing Oiler

"Speedway" thermal oilers operate automatically on temperature changes of 2 deg. Main oil supply held in bottle *A*, from which it flows as needed to thermal chamber *B*. Any slight rise in temperature of bearing expands air in *B*, forcing oil out of small opening *D*.—*Speedway Mfg. Co., 19th & 52nd Ave., Cicero, Ill.*



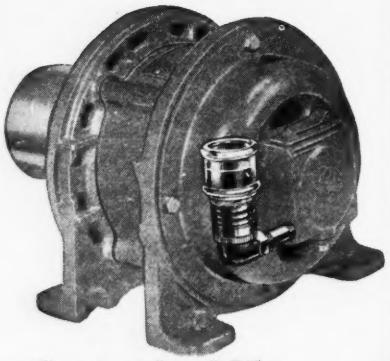
Oil Clarifier

Portable absorption unit connected directly to crankcase of internal combustion engine. Pressure of engine lubricating system utilized. Model H for diesel or gasoline engines of less than 250 hp. Model J for lighter-duty equipment requires greater frequency of changing filter element.—*Briggs Clarifier Co., Transportation Bldg., Washington, D. C.*



Industrial Lubricants

"Sta-Put" lubricants have high film strength due to special polymerization treatment. Tests indicate 40 to 65 per cent increase and reduced spatter and dripping. Three series: 300 series liquid, ranging from light machine oils to heavy; 400 series for gear lubrication; 500 series are grease consistency. Illustration compares film-forming properties of straight mineral oil (left) with same oil after treatment.—*E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa.*

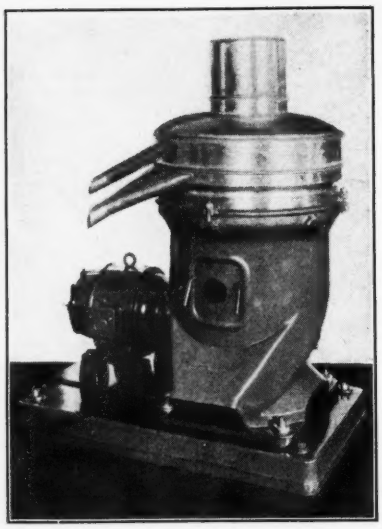


Constant-Level Oiler

Designed especially for use on motor bearings and others with oil-ring, packing, or ball or roller bearings where oil in reservoir should be maintained at predetermined level.—*Speedway Mfg. Co., 1834 S. 52nd St., Chicago, Ill.*

Lubricating Paste

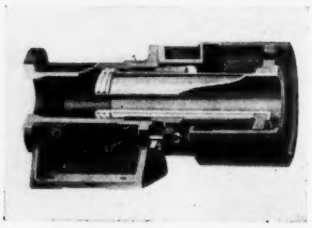
Garlock lubricating paste compound No. 2 for steam and water packings, and No. 3 for packings working against gasoline and oils, are intended to replace hand-mixed lubricating compounds. Claimed to reduce friction, obtain maximum efficiency, and prolong life of packings.—*Garlock Packing Co., Palmyra, N. Y.*



Heavy Centrifugal Separator

Rotojector Centrifugal (Titan-Patents) is capable of continuous operation on liquids containing relatively high percentage of solids. Bowl can be reversed by hydraulic pressure at full speeds and expels entire contents within ten seconds. To handle liquids with percentages of up to 10 of amorphous and slurry precipitates or for up to 10 of solids; can be used on dirtier Bunker C oil and in dehydration of tar made with Bunker C oil.—*Sharples Specialty Co., 23rd and Westmoreland Sts., Philadelphia, Pa.*

Piping, Valves and Fittings



Externally Guided Piston-Ring Expansion Joint

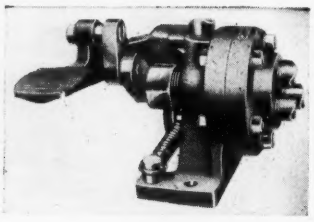
ADSCO, 400-lb., piston-ring, expansion joint sizes from 3 to 20 in. in single- or double-slip design; traverses 3 to 11 in. per slip; 400-lb. A.S.M.E. flanges or ends beveled for welding, with or without shield over gland stud openings, and with cast-iron or cast-steel bodies. Joint may be repacked without shutting off steam.—*American District Steam Co., North Tonawanda, N. Y.*

Tube Coupling

"Hi-Duty" tube couplings for copper, Shelby, aluminum, Bundyweld, Everdur, Monel and steel tubing. Complete information in Imperial Hi-Duty Data Book.—*Imperial Brass Manufacturing Co., Chicago, Ill.*

Packing Lubricating Compounds

Lubricants in 1, 2 and 5-lb. containers will lengthen life of packings in service. Full information.—*Greene, Tweed & Co., 109 Duane St., New York, N. Y.*

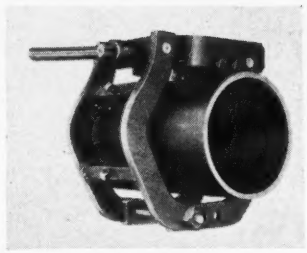


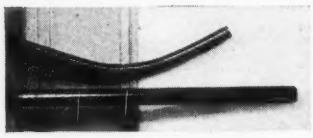
Foot-Operated Valves

Two, three and four-way types for air, steam, oil, water and gas lines. Model F-O illustrated has oscillating disk with no neutral position. On four-way type, air pressure is always on one end of cylinder when pedal is up. Model F-R embodies ratchet on stem and rotating disk. Sizes, ¼ to ¾ in.—*W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa.*

Pipe-Welding Clamp

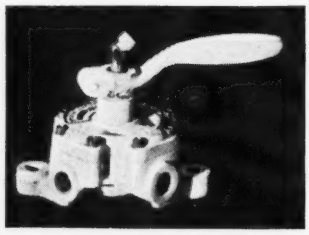
Oster "Bull-Dog" is adjustable for all sizes within either of two ranges, 4-6 in., and 8-12 in. Other sizes later. One lever controls action. Open construction leaves space for tacking. Welded-steel construction makes weights 18 and 26 lb.—*Oster-Williams, 2057 E. 61st Place, Cleveland, Ohio.*





Underground Conduit

Goodyear-Graybar electrical conduit has high resistance to water absorption and fire. High impact and crushing strength even at high and low temperatures. Sizes 5 to 8 ft. long and 1- to 6-in. inside diameter.—*Graybar Electric Co., Graybar Bldg., New York, N. Y.*

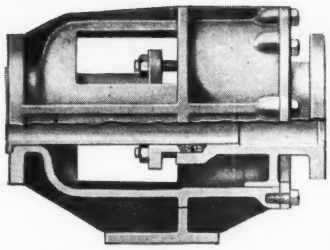


Quick-Opening Disk Valve

"Unitite" packless unit has simple arrangement for lubricating moving parts. Balanced disk pressure throughout contact area. Valve disk and bonnet may be reground without removing valve body pipe line or disturbing connections. Universal type; may be used as straightway, three-way or four-way valves. Up to 250 lb. per sq.in. Sizes ⅜ to 1¼ in.; standard or column mount.—*Hanna Engineering Works, 1765 Elston Ave., Chicago, Ill.*

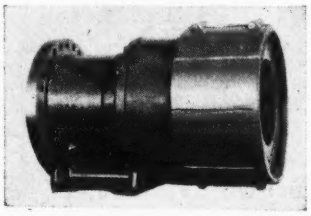
Light-Weight Welding Fittings

Welded from No. 10 gage (0.134-in.) steel. Die-formed for smoothness; center-to-end dimensions conform with 125-lb. American Standard. Plain end or flanged, or flanged one end only. Attached flanges forged steel. Suitable for pressures up to 200 lb. per sq.in. or more on smaller sizes. Inside diameters, 3, 4, 5, 6, 8, 10, 12, 14 and 16 in.—*Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill.*



Externally Guided Expansion Joint

Differs from usual joint in that sliding member is composed of stuffing box and guides, external guide being enclosed in cylinder extending full length of joint, and internal guide inside stuffing box and adjacent pipe section. Ample openings for repacking. With or without bases. Single-slip joint shown. Also double-slip. All sizes standard and extra heavy, or cast steel.—*The Direct Separator Co., Inc., Syracuse, N. Y.*

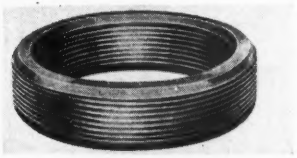


Expansion Joints for 400 Lb. Pressure

Internally-externally guided type with special anchor base. Greatest diameter of joint slightly larger than connecting flanges. Internal guide is ring secured to body end of steel slip. This guide ring and inside of joint body are machined to close fit. External guide through hood, in two pieces for ease of removal. Two parts held accurately by bolted joint. Both parts also bolted to joint body. Flange on end of slip serves both as connecting flange and guide. Inward limit stop prevents slip from taking more than pre-determined traverse. Outward limit stop prevents pulling out of slip when pipe contracts. All sizes in single- and double-slip type, with or without anchor base and with or without service connection. Almost any traverse. Flanged type joint, or either or both ends beveled for welding. — *American District Steam Co., North Tonawanda, N. Y.*

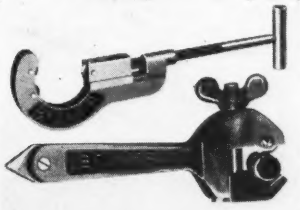
Duplex Hydraulic Valve

This valve is entirely separate from main piston and will operate cylinders in any location without valve gear. Only two pipe lines connect valve with operating cylinder. Unit can be applied to any hydraulic drive, but was designed for hydraulic stokers. Should stoker plunger encounter obstruction sufficient to stop it, motion of plunger is immediately reversed. Stoker will continue to make short strokes until obstruction is crushed or removed. In general, valve operates similarly to Worthington plunger-type meter, except that valve plunger cannot pass center until hydraulic pressure builds up sufficiently to force plunger past vertical spring-loaded wedge *A.—W. J. Woodcock, 102 Gates Ave., Brooklyn, N. Y.*



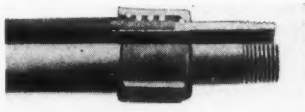
Laminated Packing for High Steam Pressures

For use in Yarway seatless blow-off valves. Consists of several strainless steel rings with long-fiber asbestos packing between. At assembly, it is compressed and heat-treated, so that finished ring is suitable for high pressures and temperatures. Indicated life six times as great as previous packing.—*Yarnall-Waring Co., Mermaid Ave., Philadelphia, Pa.*



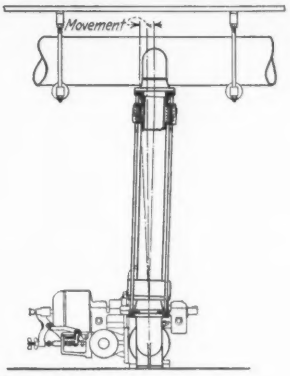
Pipe Cutters

No. 100 tubing cutter (lower) ⅛ to ⅝-in. Square-Built wheel cutter, 2½ to 4-in. No. 100 particularly used for copper. Renewable - blade reamer on handle; 6 in. long.—*The Borden Co., Warren, Ohio.*



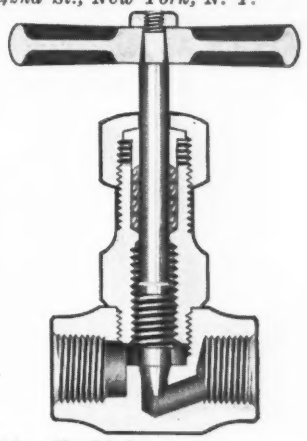
Hose Coupling

Wil-Bro couplings and menders utilize "compression collar" instead of clamping. Collar has unusual spiraled inner groove applied over coiled wire. This brings about uniform compression. Permits use of thin-walled insert; results in minimum restriction to flow. Flange on clamp end engages shoulder on coupling insert.—*Robertshaw Thermostat Co., Youngwood, Pa.*



Flexible-Disk Expansion Joint

New arrangement of "Flexo-Disc" alloy-steel expansion joint. Two short "FlexoDisc" elements connected by required length of pipe and by tie rods, with take-up reaction due to steam pressure acting on bellows themselves. Bellows permit lateral movement with no strain on piping, and absorb expansion in inter-connecting piping. Tie rods fitted with swivel nuts. Useful for eliminating expansion strains where lateral movement, as well as linear expansion, must be handled. Pressures to 300 lb.—*Croll-Reynolds Engineering Co., Inc., 17 John St., New York, N. Y.*

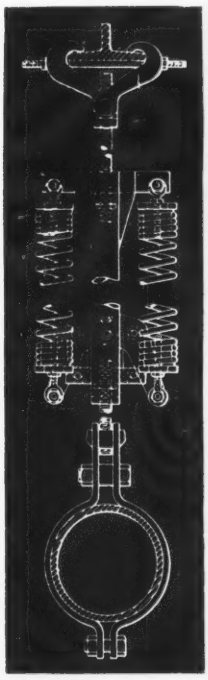


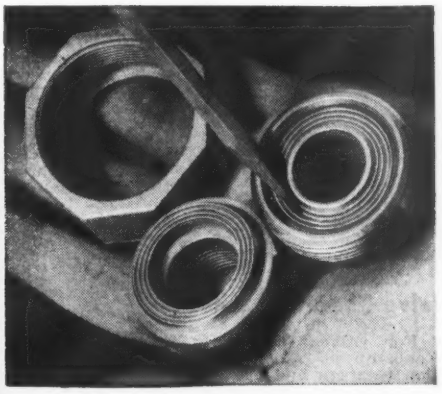
Needle Valve

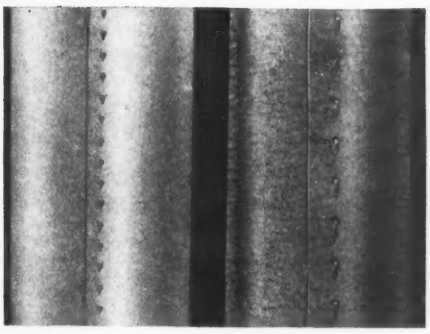
Made from carbon steel or high-chrome stainless iron. Suitable in measuring pressures or volume of flow fluids or gases where gradual release of pressure is essential. — *Crane Co., 836 S. Michigan Ave., Chicago.*

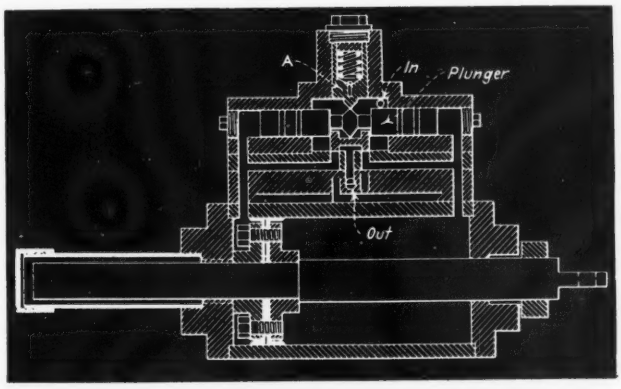
High-Pressure Union

U. S. Union has two serrated ends, one hard, other soft, which form four distinct seats instead of usual one. Can be re-used; making up does not spoil seats. —*United Superior Union Co., 29 Ryerson St., Brooklyn, N. Y.*









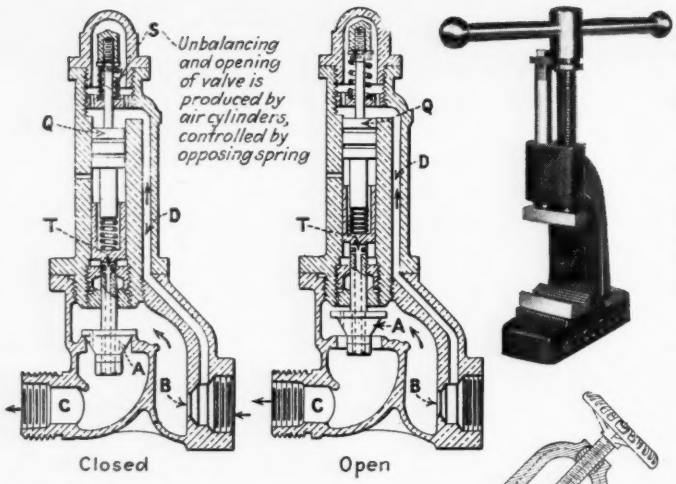
Constant-Support Pipe Hanger

"Genspring" pipe hanger provides constant supporting force for pipe during vertical movements of as much as 2 in. without permitting non-axial stresses in pipe joints or other parts of line. Also permits horizontal movements.

Pipe is supported by levers which compensate for changes in supporting effort of springs as they are deflected by vertical movements of pipe line. All loads from 500 to 7,000 lb. weigh approximately 160 lb. Greater loads and movements provided for on special order. —*General Spring Corp., 11 West 42nd St., New York, N. Y.*

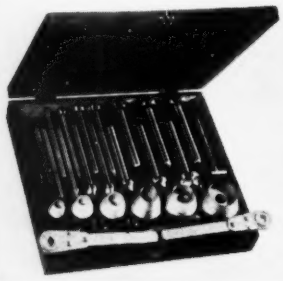
Metal Stitch for Insulation

Two types, first for applying heavy canvas over heat insulation on pipes, ducts, etc. other for applying jackets of roofing. Essentially a metal strip with arrowhead-shaped prongs bent out at right angles. Edges of canvas forced over prongs then all prongs bent back flat. Roofing covers have longer prongs spaced at 1-in. intervals. Bulletin 105.—*The Philip Carey Co., Lockland, Cincinnati, Ohio.*



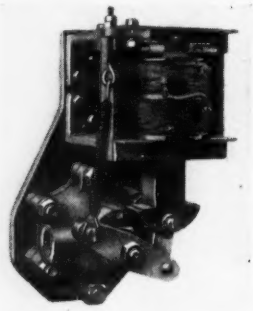
Automatic Air Line Control Valve

Yarway-Becker valve provides automatic control of air line when nipple blow-offs or disconnections occur. Normally air passes beyond plunger *A*, valve being held open by air pressure from *C* passing through cored hole in valve stem into opening *T*, which counterbalances pressure in *D* on *Q*. When air pressure at outlet suddenly drops, pressure in *D* builds up and closes plug automaticly.—*Yarnall-Waring Co., Mermaid Ave., Philadelphia, Pa.*



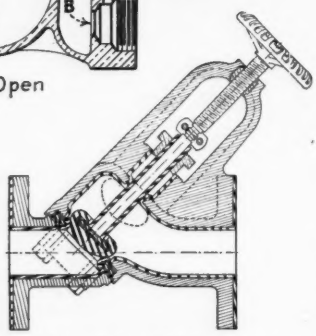
Valve Reseating Kits

For valves from ¼ to 2 in. Tools up to 2 in. are combination reamers and special thread tap, making unit self-feeding. In larger sizes, reamer and tap are separate tools.—*Saver Renewable Seat Tool Co., 549 West Randolph St., Chicago, Ill.*



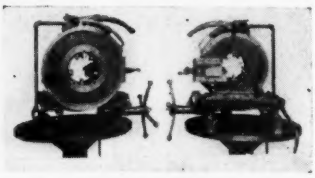
Solenoid-Operated Valves

Two-, three- and four-way types. Unit operates single- or double-acting cylinders by remote control through pushbutton or automatic time-cycle device. Embodied is flat-disk, regrinding type valve. Two models for operation on 110, 220 440 or 550 volts, a.c. or d.c. Also special valves.—*W. H. Nicholson & Co., 125 Oregon St., Wilkes Barre, Pa.*



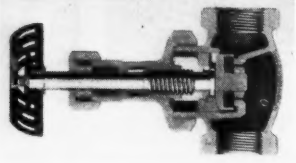
Rubber-Lined Valve

Vulcalock valves handle corrosive and abrasive fluids under fairly high pressure, pulsating pressure, throttling or suction. Valve lined with any standard Acid-seal rubber compound hard or soft. Resilient rounded disk snaps over circular plate at lower end of steam provides seal with molded rubber-covered seat. Both disk and ring replaceable. Can be changed quickly from straightway to angle valve. Cast-iron body of two-piece Y construction to withstand working pressures up to 150 lb.—*B. F. Goodrich Rubber Co., Akron, Ohio.*



6-In. Die Head

No. 706 die head can be installed in old pipe machines. Makes any 6-in. machine cover all sizes from 1 to 6 in., and bolts from ¾ to 5 in. Head calibrated for Briggs Standard but can be marked special. Head equipped with single high-speed cutting blade or gibbed slide, screw-operated.—*Oster-Williams Corp., Cleveland, Ohio.*

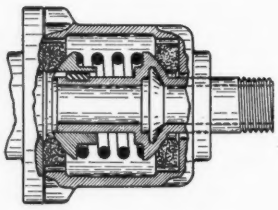


Non-Metallic Disk Valve

Fig. 123 "N-M-D," bronze valve suitable for 150-lb. steam pressure and 300-lb. gas-liquid pressure. Valve repackable under pressure. Disk holder slip-on type. Three basic types —steam, hot water, cold water, air. Designs—globe, angle, horizontal and angle check, spring check for compressors. Booklet F-593. — *The Lunkenheimer Co., Cincinnati, Ohio.*

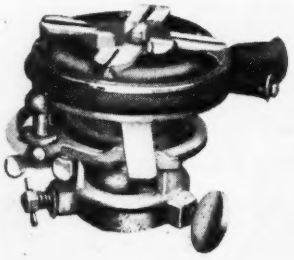
Open-Side Pipe Vise

Three sizes, No. 00 (capacity ⅛ to 1½-in. pipe), No. 0 (⅛ to 2½-in. pipe), and No. 3 (⅛ to 4½-in. pipe). Heavy frame and long full over-lapping jaws. Handles over-size. Jaw construction permits working close to vise face. — *Toledo Piping Threading Machine Co., Toledo, Ohio.*



Rotary Pressure Joint

Special carbon-graphite seal rings that do not require lubrication. Pressure equalizing within joint seals polished concave surfaces of seal rings against chromium cast-iron spherical flanges. Light spring merely holds parts in place. Lateral movement possible in addition to angular movement. Steam pressures exceeding 200 lb. and speeds of 200 r.p.m. Sizes ¾ to 3 in.—*Johnson Corp., Three Rivers, Mich.*

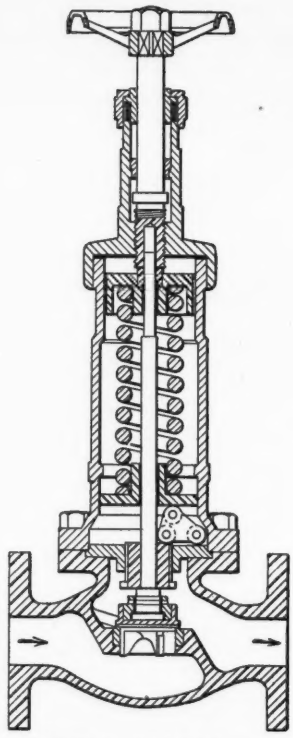


Ratchet Die Stock

No. 12R Beaver ratchet is fully self-contained and adjustable 1- to 2-in. threader. Supplied complete with dies. Ratchet drive ring on die head; dies on top.—*Borden Co., Warren, Ohio.*

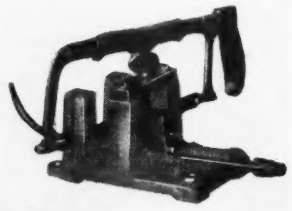
Steam Pipe-Line Conduit

USCCO precast concrete conduit gives greater strength, capacity and economy. Simple and flexible. Shape increases capacity 12 per cent over circular conduit and gives space for saddles and roll supports. Only two sections, tops and bottoms, with bell and spigot joints sealed with mortar or joint compound. Built on job in 4-ft. lengths, with cast-steel pipe supports inserted where necessary.—*Underground Steam Construction Co., 75 Pitts St., Boston, Mass.*



Fuel-Oil Relief Valves

Special relief valves have spring link compensating mechanism between sliding plug and spring plate. Average variation compensates for increased tension of spring as valve lifts. Screw spindle permits pressure adjustment from 15-600 lb. —*Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.*

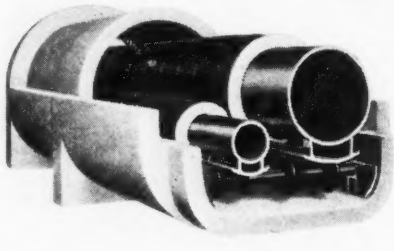


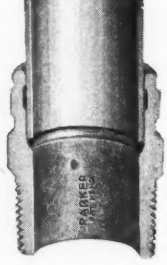
Square-End Sawing Vise

Beaver vise for thin-wall copper or brass tubing, ⅛ to 2 in. in diameter, will not crush nor mar pipe. Aluminum, accompanied by cotton webbing and rosin for use when cutting polished tubing.—*Borden Co., Warren, Ohio.*

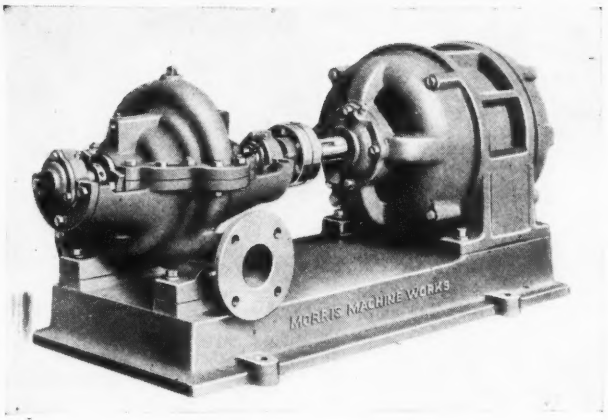
Copper Pipe Fittings

Parker "Innerseal" fittings "make-up" pressure tight with tube without solder. Seals at both ends of joint and has "pockets" to better bond. Color band indicates proper soldering temperature. All types and sizes.—*Parker Appliance Co., Cleveland, Ohio.*





Pumps For Power Plant and Industrial Uses

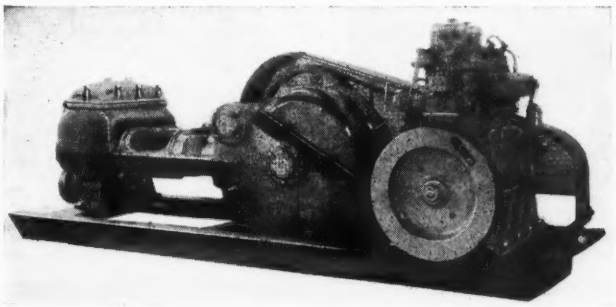


Double-Suction Split-Case Pump

For high-speed operation. Suitable for direct connection to motors or turbines running at 3,500 r.p.m. May also be belt driven or operated through gears. Ball bearings handle all thrust loads. Sizes ½ to 5 in.—*Morris Machine Works, Baldwinsville, N. Y.*

Diesel-Driven Power Pump

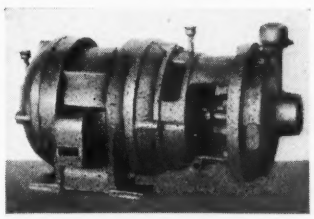
This 8x10 Gardner-Denver, duplex - piston, self - lubricated power pump is V-belt driven by 20-hp. Hill diesel. Capacity 500 g.p.m. against total dynamic head of 115 ft. Larger or smaller units available. — *Gardner-Denver Co., Quincy, Ill.*



Rotary Positive Displacement Pump

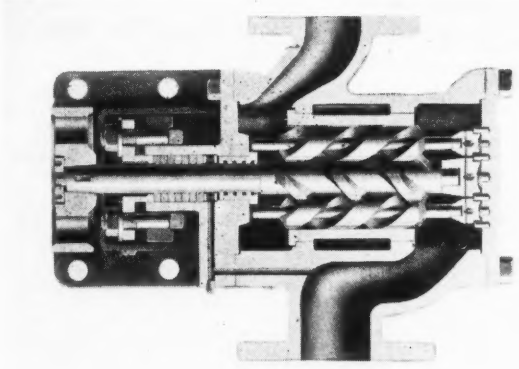
(Photo below)

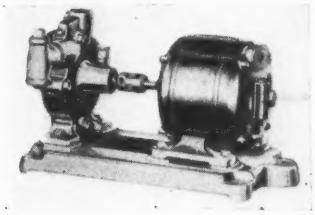
DeLaval-1MO rotary displacement pumps run at speeds heretofore considered impracticable. Power applied to central or power rotor, which meshes with one or more sealing rotors propelled largely by fluid pressure, with minimum mechanical contact. Sealing effective. Efficiencies 80 to 90 per cent. Liquid velocity through pump low; no trapping or cutting off of liquid in tooth pockets. Only three moving parts. No separate bearings nor pilot gears. One stuffing box. Capacities ½ to 700 g.p.m., pressures to 500 lb. per sq.in. Pumps for higher pressures and capacities also.—*DeLaval Steam Turbine Co., Trenton, N. J.*



Motor-Pump Unit

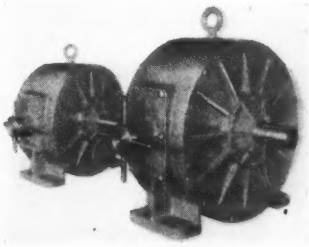
Three new "SSU" motor-driven, single-shaft, 2-bearing pumping units. Heads up to 100 lb. (231 ft.) and above; capacity 30 to 140 g.p.m. Motor rotor and pump impeller on same ball-bearing shaft.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*





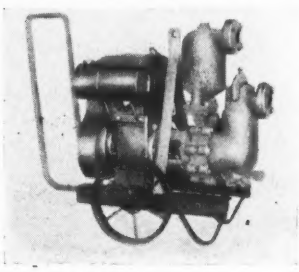
Regenerative Turbine Pumps

Suitable for handling even small quantities of liquids efficiently at high heads. Capacities 5 to 300 g.p.m.; heads to 350 ft. Taper - edge impeller permits varying quantities while running. Slight increase in capacity as head falls, with noticeable decrease in power consumption. Suction and discharge openings both in main pump housing.—*Roots - Connersville-Wilbraham, Connersville, Ind.*



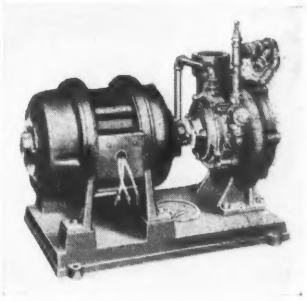
Hydraulic Pumps, Motors

Series 5000 "Northern" hydraulic pumps and motors of the rotary radial-piston type in units from 1—200 g.p.m. and pressures of 4,000 lb. per sq.in. Discharge variable from 0 to maximum capacity and discharge can be reversed without stopping. Available with complete line of automatic controls and semi-automatic valve mechanism. Incorporate balanced-pressure design. — *Northern Pump Co., Minneapolis, Minn.*



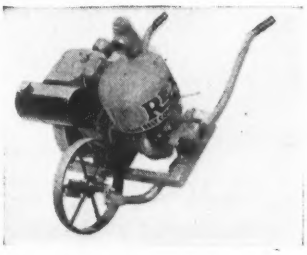
Portable Pump

No. 15 WPD and No. 20 WPD have no valves or other priming mechanism and no recirculation or capacity loss after prime is established. Guaranteed suction lift 20 ft. at sea level. Sizes 2½x2 (160 g.p.m. at 20-ft. suction or 100 at 50-ft.) to No. 40 DHL 6x5 (800 at 20-ft. or 500 at 60-ft.) Engines 3-25 hp.—*La Bour Co., Elkhart, Ind.*



Single-Suction, Self-Priming Pump

Buffalo "CP" is compact, economical. Two types of impellers: open, where liquids are not clear, and enclosed impeller for clear liquids. Built-in self-primer, under license from Nash Engineering Co. Pump shaft, bronze covered, is extension of motor shaft. Both radial and thrust loads taken by motor bearings. No couplings. Gland split type. Several sizes in capacities 450 g.p.m. and heads to 150 ft.—*Buffalo Pumps, Inc., 488 Broadway, Buffalo, N. Y.*

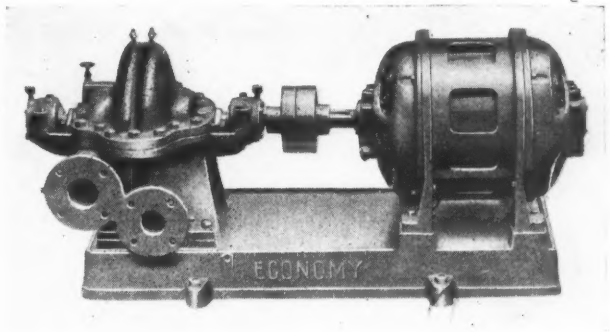


3-in. Self-Priming Centrifugal Pump

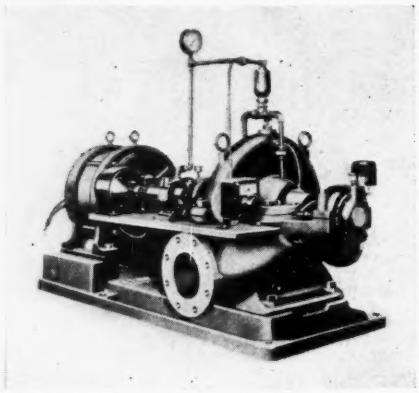
REX self-priming unit is of recirculating type and is automatic in action after recirculating system is once filled. Weighs 385 lb., is 34 in. high and 37 in. wide. Capacities: 5-ft. suction lift, 20,400 g.p.h.; 15-ft. suction lift, 16,500 g.p.h.; 25-ft. suction lift, 9,000 g.p.h. Impeller can handle high percentages of solids, and will pass sphere up to 1½ in. in diameter. Powered by 6-hp. air-cooled engine. Motor drive can be furnished. Bulletin 230.—*Chain Belt Co., Milwaukee, Wis.*

Two-Stage, Opposed-Impeller Centrifugal

Ball-bearing, horizontal, split-case. High efficiency at moderate speeds. Suitable for drive



by motor, gasoline engine or steam turbine. 300-g.p.m. pump operating against 150-lb. pressure has shaft length of 27 in. Compact construction. Bulletin 426.—*Economy Pumping Machinery Co., 3431 W. 48th Place, Chicago, Ill.*



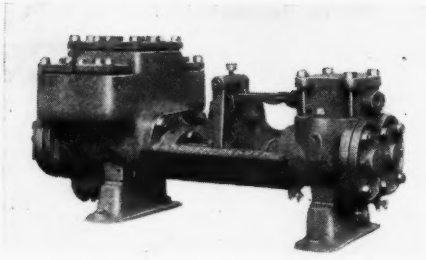
Self-Priming Systems for Centrifugal Pumps

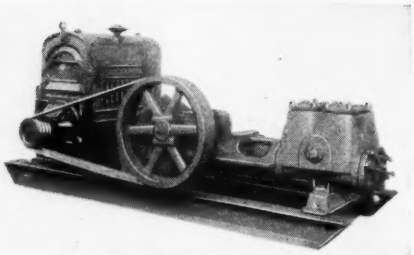
Small motor-driven rotary vacuum pump mounted on centrifugal pump evacuates air in pump and suction line. Started by pushbutton or remote control. When pump is fully primed, motor is started. Building up of normal pressure in discharge line stops vacuum pump, but should pump lose prime it is automatically stopped, vacuum pump started, and priming cycle repeated. Protective controls prevent continual repetition of priming cycle. — *Pennsylvania Pump & Compressor Co., Easton, Pa.*

Steam Pump

(Top Center)

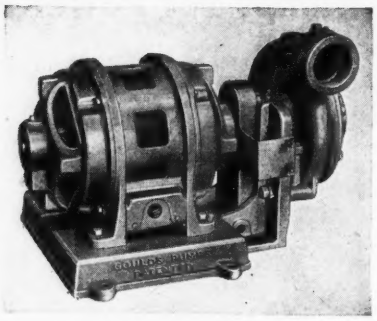
Small, high-pressure, duplex, direct-acting steam unit with pot-valve-type fluid end. Master size is 4½x3x4, but either 2 or 2½-in. diameter liners and fluid pistons may be substituted. Bulletin P-36.—*Gardner-Denver Co., Quincy, Ill.*





Gasoline Engine-Driven Power Pump

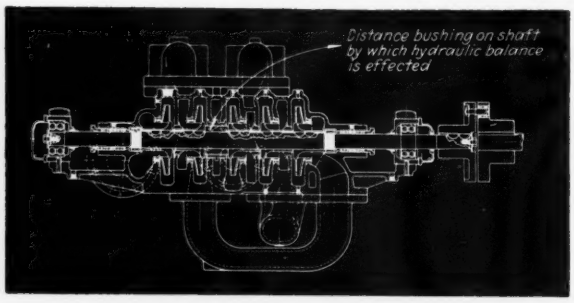
4x6 Gardner-Denver horizontal duplex double-acting power pump driven by V-belt from 4-cyl., 4-cycle vertical gasoline engine. Mounted on rigid H-beam steel skid V-belts tightened by moving engine with jackscrews. Used principally for water supply. Bulletin P-36. —*Gardner-Denver Co., Quincy, Ill.*



Motor-Centrifugal Pump

(Top Right)

Close-coupled mounting uses standard motor on pump bedplate. Sizes ¾ to 4-in.; capacities to 1,000 g.p.m. Heads 10 to 290 ft.; 1,750 or 3,550 r.p.m. Bulletin 204. — *Goulds Pumps, Inc., Seneca Falls, N. Y.*

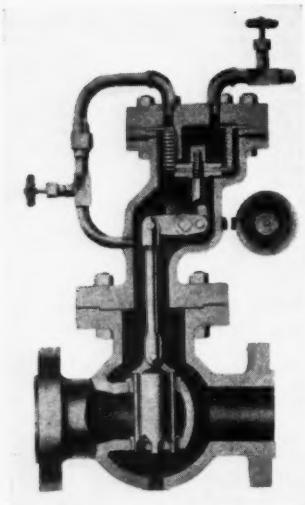


Hydraulic Balance in Multi-Stage Centrifugal Pumps

(Left)

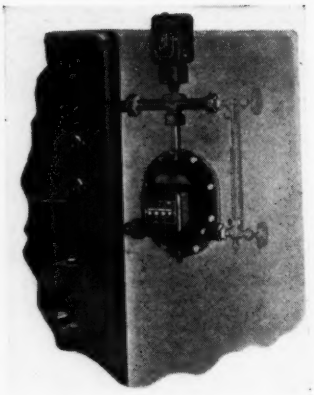
Where number of stages is even, half of impeller inlets face left-hand, half right-hand. In odd-stage pump one less suction inlet faces left-hand. In all pumps, at about center line, two impellers directly opposed. Balancing accomplished by placing proper diameter distance bushing between two directly opposed impellers. Ball thrust bearing in outboard bearing. Avoid leakage and excessive wear. — *Pennsylvania Pump & Compressor Co., Easton, Pa.*

Regulators and Controllers



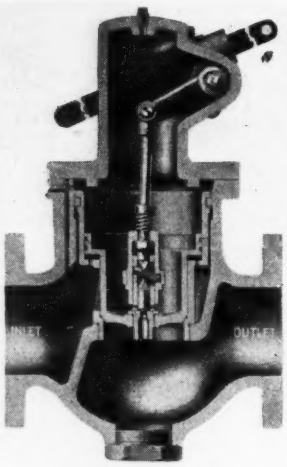
Differential-Pressure Control Valve

Copes Type SS-2 is improved Type SS. Improved internal construction, ¾- to 6-in. sizes, in 250-, 400- and 600-lb. pressure. Range of control is 10 to 3 lb. per sq.in. differential pressure. Handles pressure drops up to 150 lb., depending on size. —*Northern Equipment Co., Erie, Pa.*



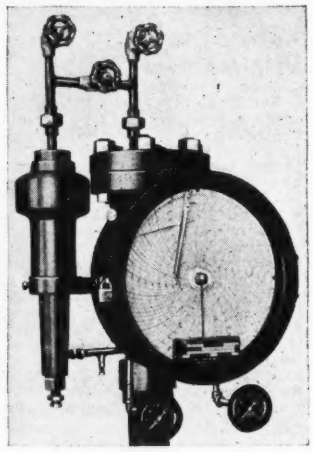
Low-Water Control

This bellows-sealed, packless, low-water cutoff, duplex switch and water feeder permits low-water protection at small cost. Designed for gage-glass mounting. Offers both types of low-water protection — low-water cutoff operates mercury switch in electrical circuit to cut off power until boiler is manually refilled, or automatic switch may be added for automatic boiler refilling by means of solenoid-operated valve. Pressure or vacuum to 25 lb.—*Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*



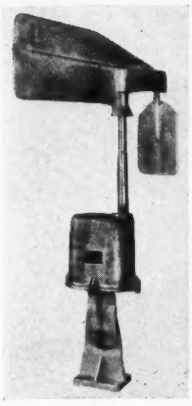
Pilot-Controlled Regulation Valve

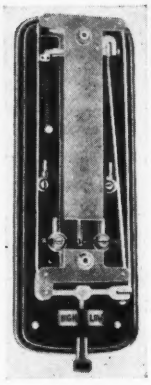
Float on water level in tank, heater or other vessel actuates small pilot valve, which controls pressure on plunger connected with main flow-regulating valve. Smooth variation of flow. Auxiliary multiplying lever enables small float with limited travel to control pilot accurately under high pressures, while retaining high lift of pilot and main valve. When closed, both main valve and pilot held drop tight to seat by pressure. Dampening chamber prevents chatter.—*Cochrane Corp., 17th and Clearfield Sts., Philadelphia, Pa.*



Flow Controller with Magnetic Clutch

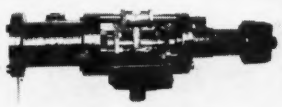
Utilizes magnetic clutch instead of conventional pressure-tight bearing. Suitable for 2,500 lb. working pressures. All internal parts stainless steel in mercury. Clutch operates pen positively. Differential range readily made either 20, 50, 100 or 250 in. of water. 100-in. range volumeter also enables use of chart graduated uniformly in units of flow. Allows use of standard flanges; universal mounting for 2-in. vertical pipe or wall or panel mounting. Complete line of orifice meters also in this type.—*C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.*





Modulating Thermostatic Temperature Control

"Superstat" instrument integrates effect of wind velocity, sun, and outdoor temperature into common effect converted into valve position by power unit. Twelve valve positions in range of 65 deg. F. plus wind velocity value. All automatic. Wider temperature range for rigorous climates. Standard relative values are 10 parts motion for temperature, 4 for wind and 2 negative for sun. Maximum steam at zero F. with 40-mi. wind.—*Superstat Co., 38 Walter St., Springfield, Mass.*



Automatic Proportioning Pump

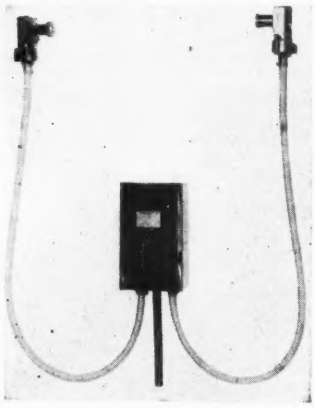
"Tret-O-Unit" horizontal, automatic reciprocating proportioning pump, uses any fluid under pressure as motive power. Fluid to be treated or samples (for example, feed water) passes through water meter or other flow-responsive device coupled to gear box of "Tret-O-Unit." Special flow-responsive rotor (Roto-Flo) available to measure flow of corrosive fluids. — *Proportioneers, 9 Codding St., Providence, R. I.*

Double-Control Regulator

Improved after tests at Bohlen Power Station, Germany. Feeds boiler in accordance with steam flow, with compensation for water level. New type of mechanical transmission provides steam-flow thermostat near connections to steam header. Any desired proportion between steam flow and water level. Can be equipped with either direct-acting or hydraulically operated control valve, or with combined feed flow and water-pressure regulating valve. — *Northern Equipment Co., Erie, Pa.*

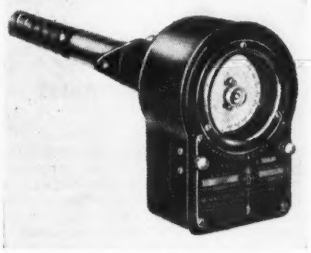
Open-Contact, Low-Voltage Humidity Control

"Humitrol," for use on low-voltage air-conditioning systems up to 25 volts. Direct application to equipment drawing 25 watts or less. Controls humidity at any desired percentage up to 100. In-and-out operating range adjustable to 1 per cent differential.—*Lewis Air Conditioners, Inc., Minneapolis, Minn.*



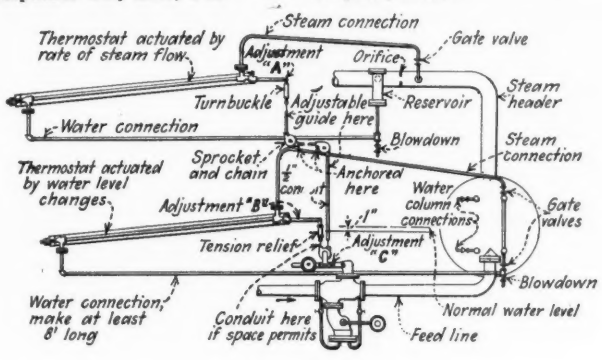
Photoelectric Controller

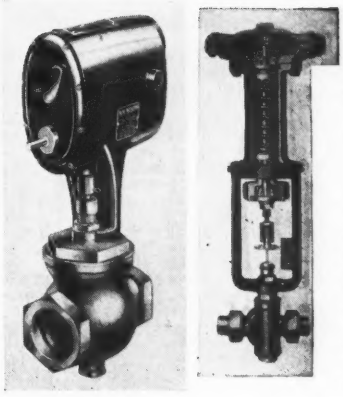
"Photo-Troller" light-sensitive controls are actuated by phototube or delicate contacts carrying only a few microamperes. Photo-tube operates grid-glow tube directly, which in turn closes contactor capable of initiating desired operation. Sheet-metal cabinet with door and knockouts. Any a.c. commercial voltage or frequency, but not d.c.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



Indicating Temperature Controller

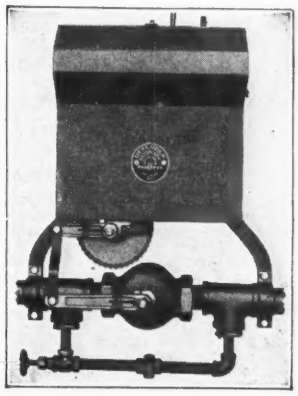
Type L48-4 temperature controller (shown) L68 and L93 controllers indicate and control temperature of air, gases or liquids. Self-contained actuating electrical contacts which govern mechanisms of heat supply. Three models, varying in assembly of bi-metallic temperature-sensitive element, each for various electrical control circuits. Bulletin Page L39.—*Minneapolis-Honeywell Regulator Co., 2702 Fourth Ave., Minneapolis, Minn.*





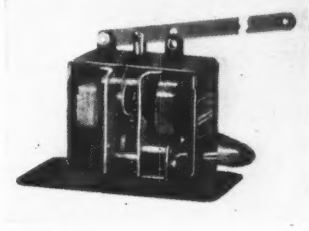
Proportioning Motor Valve

Type V 92-1 motor valve constitutes part of a new electric control system. Unit operated from thermostat, expansion thermometer, humidistat, pyrometer or pressure switch, arranged with slide-wire mechanism. — *Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*



Motor-Operated Pressure Regulator

Actuated by pressure, vacuum, temperature, volume, time or flow, and usable on horizontal and vertical pipe lines, these units operate valves. Adjustable compensating type, having face plate with stops on front of cogwheel; 5 different face plates, with 16, 8, 4, 2 stops or blank that permits full travel forward or backward on one contact change. Unit makes stops on any increment of pressure change desired from 1 to 10 lb. Actuating medium is hollow coil spring. Regulator will work from 20 in. of vacuum to 250 lb. pressure. — *Defender Automatic Regulator Co., 308 S. 8th St., St. Louis, Mo.*

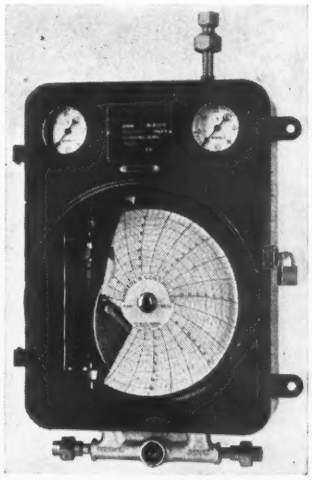


All-Electric Motor Power Unit

Type M94-1 "Modutrol" motor provides mechanical motion in proportion to demands of temperature or pressure controllers. Controls air flow, or, when provided with suitable linkage, will modulate flow of gases or liquids through valves. — *Minneapolis-Honeywell Regulator Co., 2702 Fourth Ave., South Minneapolis, Minn.*

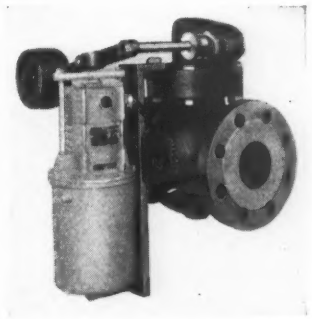
Diaphragm Valve

Improved super-structure mounted on TAG V-port balanced valves, giving gradual opening characteristics. Friction cut to minimum by reducing diameter of spindle passing through stuffing box. Spindle guided by upper (large-diameter) portion which passes through two roller-bearing assemblies. Spring (single or multiple) is inclosed, as is diaphragm. Positive indicator furnished. Adjustments easy.—*C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.*



Time-Temperature and Time-Pressure Controllers

Regulate a temperature (or pressure) to some fixed rate, then either hold it or decrease it at some other rate. Any range of temperature from 40 to 1,000 deg. F., or pressure from 10 to 2,000 lb. Model 8040 MT illustrated is large-cam type. Cam is graduated chart on sheet aluminum cut by user to give desired characteristics. Cam driven by Telechron or spring clock. Air supply and control gages mounted. Compact moisture-proof aluminum case. Model 7240 MT similar, but equipped with indicating pointer which shows instantaneous pressure or temperature.—*The Bristol Co., Waterbury, Conn.*



Thrustor-Operated Control Valve

Provide centralized remote control of flows of gases or liquids under pressure. Operated by G.E. thrustor in one direction only. Weight returning valve to original position

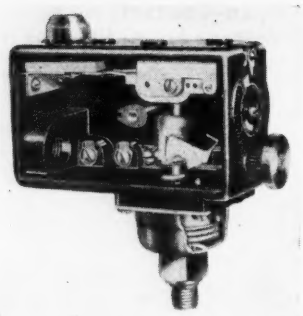
when circuit is broken. Controlled by pushbutton or time switch; external adjustment provided. Operates up to 40 times per min. No limit switches. Either 110, 220 volt, 60 to 25 cycle, a.c., 125 or 250 volt d.c. Valve is Copes Type B1, designed for specified pressure drop and flow.—*Northern Equipment Co., Erie, Pa.*

High-Temperature Automatic Control

"Potentiometer Stabilog" for temperatures up to 2,800 deg. F.; long-distance potentiometer measuring system makes instrument useful for remote control. Unit is non-recording, but may record on recording potentiometer-pyrometer with same thermocouple.—*The Foxboro Co., Foxboro, Mass.*

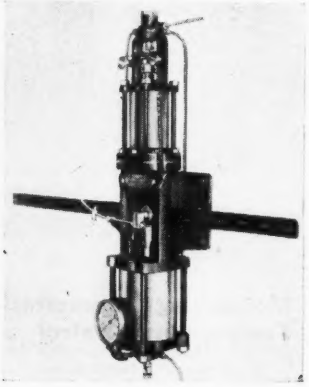
Thermometer Controller

Mercury switches eliminate open make-and-break contacts controlled by pen arm in this automatic-control thermometer. Every 6 sec., motor-driven control table determines location of pen on chart in reference to control setting and tilts mercury switch if temperature has changed. Switches have capacities up to 15 amp. at 110 volts (10 amp. at 220 volts). Control mechanism adaptable to 1-, 2- or 3-contact control systems. In 2-record controller, each control mechanism can handle a separate device. Unit also supplied as time-temperature cycle controller, with transparent cam shifting control index with relation of time. All models in circular 10-in. or 14-in. dustproof cases. Catalog No. 6702. — *Brown Instrument Co., 4490 Wayne Ave., Philadelphia, Pa.*



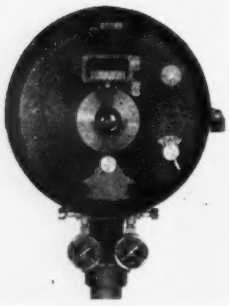
BX or conduit. Single-pole, single-throw, either "make at low," "make at high" or double throw.—*Detroit Lubricator Co., Trumbull, Lincoln, Marquette & Viaduct, Detroit, Mich.*

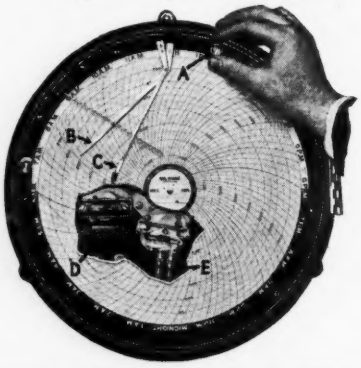
trol can operate up to six separate circuits in any desired sequence. Capacities 0 to 445 ft. head of water; differential setting, 1 to 60 per cent.—*Water Level Controls Co., 765 Hampden Ave., St. Paul, Minn.*



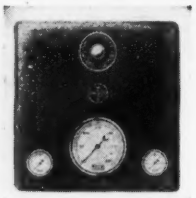
Regulator for Combustion Control

For smaller and medium-sized boiler plants. 4½-in. cylinder and operating arm with 12-in. travel at outer end, thus will control dampers, firing valves, air inlet louvers, forced-draft fans, stoker steam valves, and rheostat. For controlling boilers under steam pressures from 3 to 450 lb. per sq.in.—*Morey & Jones, Ltd., 912 S. Hemlock St., Los Angeles, Calif.*





Records and Controls Temperatures up to 1200° F.
(a) Knob for changing setting of B. (b) Index showing temperature at which control is set. (c) Temperature pen. (d) Electric motor selects switch position, depending upon relation of C to B. (e) Mercury in glass switches, capacity 15 amperes at 110 volts, positive in action, are mechanically positioned by motor D. No power required from pen. Eliminate relays in most applications.

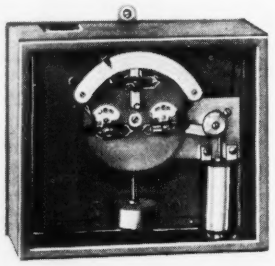


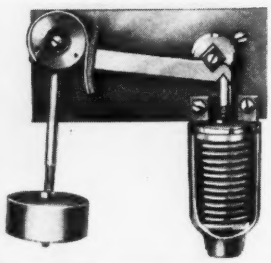
Differential Draft Control System

Instrument type, regulates amount of air passing through furnace in accordance with natural draft of stack, also quantity of fuel consumed. Controls feed of forced- or induced-draft blowers, inlet, or up-take or stack dampers, or other means. Air-operated. — *Mason Neilan Regulator Corp., 1190 Adams St., Boston, Mass.*

Control Switch

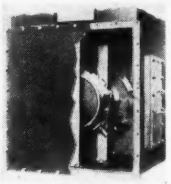
Nos. 250 and 251 "Genuine Detroit" for pressure, vacuum, and temperature carry full-line current of 110 or 220 volts. Bellows element actuated by pressure direct or by volatile liquid for temperature. Permanent magnet at contacts provides quick make-and-break with automatic starting switch units of any size may be controlled. Operating range and differential adjustable. ½-in. connection for





Rotary Multi-Contact Control

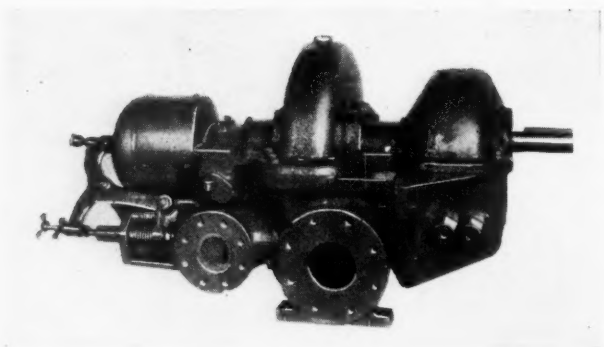
"Roto-trol" applies principle of springless scale to pressure control. Disk on front face of diaphragm-operated pendulum fulcrum carries several mercoid switches, each also adjustable to close or open at a given point of pendulum swing. Thus con-



Voltage Regulator

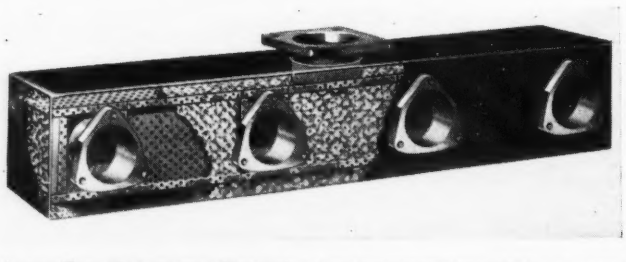
Automatic feeder voltage regulator used where induction type has previously been used. Also used on higher operating voltages. Operates on basis of an automatic tap-changing device, with suitable transformers, built into small unit. Either indoor or outdoor for single- or three-phase operation.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

Steam, Oil and Gas Prime Movers and Auxiliaries



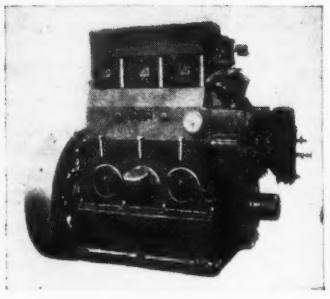
Close-Coupled Turbine-Gear Sets

Self-lubricated. Housing bolted together to form single structure supported on turbine base. Steam pressures up to 400 lb. temperatures to 750 deg. F. and back pressures to 40 lb. gage. Speed of low-speed shaft 180 to 3,000 r.p.m. Capacity from 10 to 150 hp. — *General Electric Co., Schenectady, N. Y.*



Muffler-Silencer

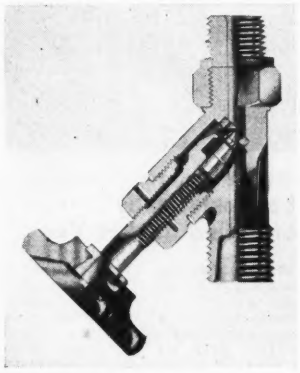
For either exhaust or intake. Incorporates silencing effects ordinarily performed by separate muffler. Gas passes through porous material laced with perforated metal lining. Sound penetrates absorbent material freely but gas flow is not appreciably impeded. No baffle plates or other deflectors. Initial efficiency maintained. Reduced possibility of muffler explosions. —*Burgess Battery Co., Madison, Wis.*



Natural-Gas Engine

High-speed, 30-100 hp. at 1,000 r.p.m., 4-cycle, single-acting. Electric starter. Starting

dynamo can be attached. Heat consumption, ¾ to full load at 1,000 r.p.m., 10,000 B.t.u. per b.hp. hr. Half load, about 12,800 B.t.u. per b.hp. hr. Illustrated is 60-hp., 3-cyl. unit. Made by M. A. N. Co.—*F. J. Joerger, 40 Rector St., New York City.*

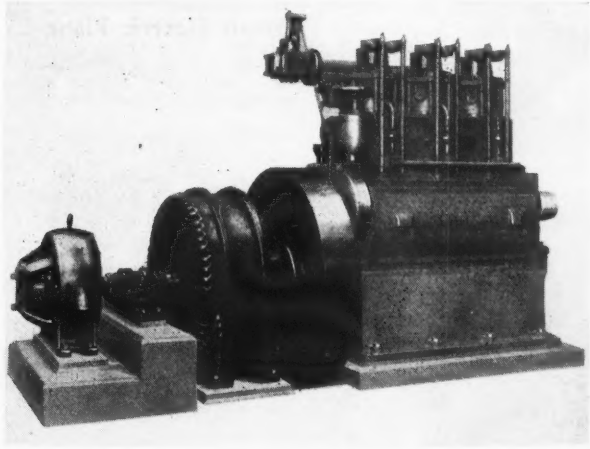


Indicator Valve for Diesel Engines

Maihak double-seated valve provides straight gas passage. When closed, pressure on indicator is released through bonnet vent hole. When open, beveled spindle collar makes tight contact with beveled surface on bonnet. V-shaped body cuts mounting space; handwheel is right at indicator. Bulletin 1267.—*Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.*

High-Speed Steam Engine

Type S4-1002 single-acting steam engine, weighing about 24 lb. per hp. and occupying 15 sq.ft. (100-hp. size), operates under loads from 50 to 150 hp. at 600 to 1,200 r.p.m. Can be used economically in condensing and in high back-pressure conditions. Four 6¾x7-in. cylinders in line. Cam and spring-actuated poppet valves. Main exhaust at end of downward stroke through fixed unvalved ports, 6-ring trunk pistons uncovering ports at end of working stroke only. Various camshafts change engine characteristics. Full-pressure circulating lubrication system; engine completely inclosed. Starting, stopping and speed control provided. Reverse

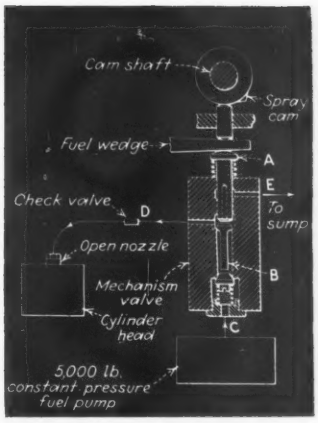


Vertical Gas Engine

Four-cycle gas engines with one to eight cylinders and 30 to 150 hp. per cyl., giving units 30 to 1,800 hp. Common mixing valve adjustable through single handscrew (separate air and gas mixing valves independently adjustable for each cylinder used in largest engines). Air inlet and exhaust valves in removable and interchangeable cages, exhaust valve cages being water cooled. Attached reciprocating oil pump. Camshaft driven from flywheel end by silent spur gears. Readily convertible to diesel.—*Worthington Pump & Machinery Corp., Harrison, N. J.*

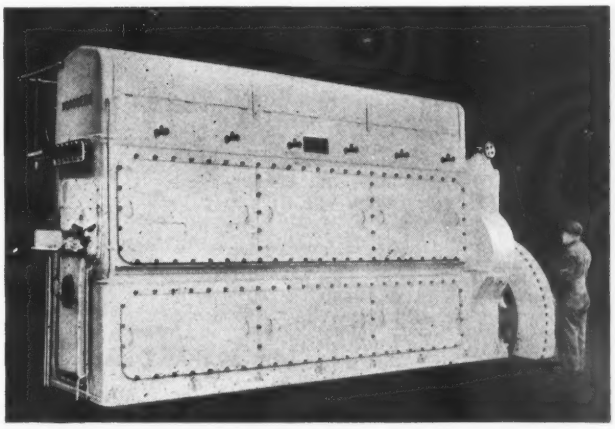
Four-Cycle Diesels

Units from 250 to 1,000 hp. operating 4-cycle and smaller units from 150-300 hp. Complete enclosure, even at top; flywheel only visible moving part. Trunk-piston, solid-injection type. Removable liners. Force-feed lubrication for cylinders, other parts by continuous-pressure. Engine controlled by single lever. Individual fuel pumps for each cylinder mounted to cylinder back and set directly over camshaft adjacent to cylinder served. Facility for hand operation. Complete piping systems for cooling water, starting air, fuel and lubricating oils, exhaust. All incoming air passed through filters in upper covers. Other



Diesel Fuel-Injection System

Cooper-Bessemer's new system operates thus: When cam opens valve, plunger *A* pushes against end of valve *B*, closes hole to center of *A* through *B*, then goes through line *D*, through check valve and into open nozzle in cylinder head. As soon as injection period is over, spring under head of *A* lifts it away from *B*, opening passes through center of plunger to atmospheric opening *E*. Check valve *D* in line prevents compression in cylinder from blowing any fuel back through nozzle. Any leakage past *B* has easy access to *E*, therefore cannot cause smoke due to dripping.—*Cooper-Bessemer Corp., Mt. Vernon, Ohio.*



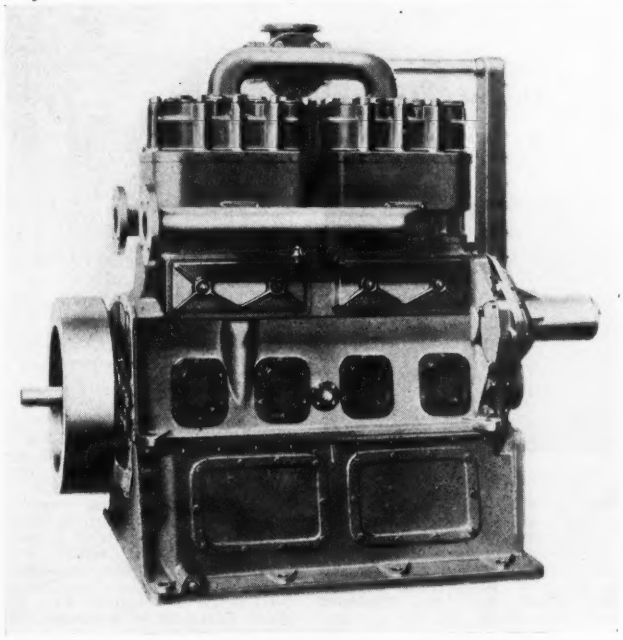
built-in elements: fuel-transfer pump, pressure strainer and cooler for lubricating oil, fuel-oil filter. Bulletin 51.—*Nordberg Manufacturing Co., Milwaukee, Wis.*

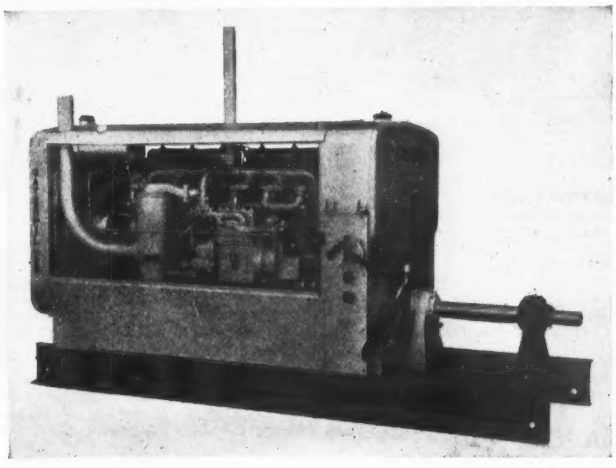
102-Hp. Portable Diesel

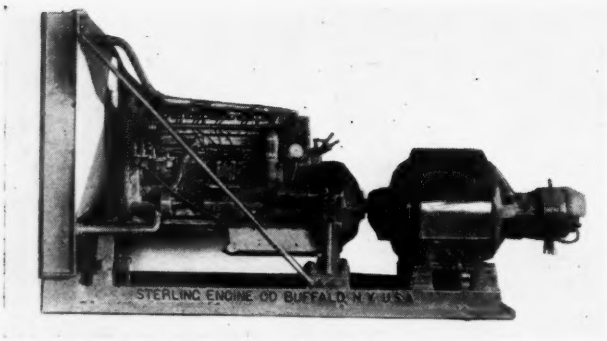
"Caterpillar" 5¼x8-in. D-11,000 develops 102 b.hp. max. at governed speed of 820 r.p.m. 144¼ in. long, 66¾ in. high, 47¾ in. wide and weighs 7,547 lb. 7-bearing balanced crankshaft, force-feed lubrication to principal bearings, air cleaner, fuel filters. Positive starting by Bendix driven by auxiliary 2-cyl. gasoline engine. — *Caterpillar Tractor Co., Peoria, Ill.*

Engine-Generator

Sterling Petrel 5¼x6-in. engine, rated at 115 hp. 1,200 r.p.m. Direct-connected to 45-kw., G.E.







generator. Engine cooled by fan and Young radiator. On cast-iron bedplate with generator. Twin carburetors, duel ignition, gasoline pump, oil filter and control panel. — *Sterling Engine Co., 1270 Niagara St., Buffalo, N. Y.*

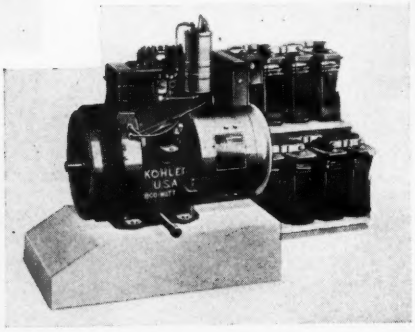
6x9-In. Vertical Gas Engine

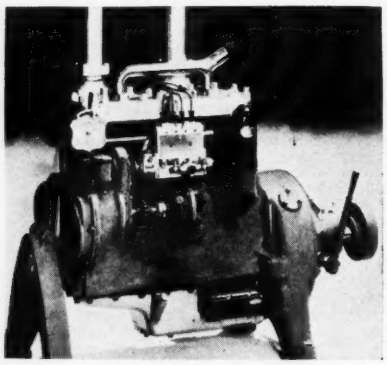
This vertical 4-cycle gas engine can be changed readily to solid-injection diesel, and will operate economically on either natural or refinery gas. Moderate-speed. All moving parts inclosed. Same regulating valve mechanism as horizontal engine. Automatic lubrication. Two, three, four or six cylinders; 20 to 100 hp. Bulletin 430.—*National Transit Pump & Machine Co., Oil City, Pa.*

be run at speeds from 200 to 2,000 r.p.m. without exceeding fuel consumption of 0.5 lb. per b. hp. hr. or giving smoky exhaust; 1 to 8-cyl. sizes, using same size parts. — *American Diesel Engine Co., Oakland, Calif.*

Small Electric Plant

Has 2-cyl., valve-in-head, 1¾-hp., air-cooled engine and develops 800 watts at 32 volts d.c.

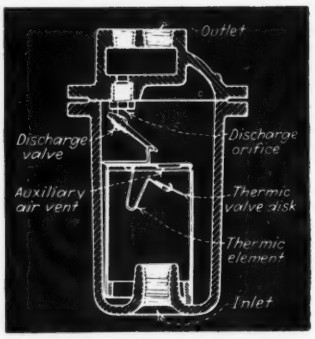




Monovalve Diesel

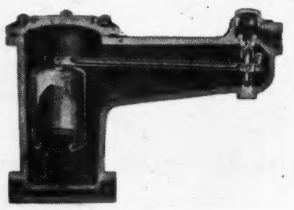
Conventional L-head design with only one valve per cylinder. Develops 75 hp. at 1,200 r.p.m. Fuel consumption 0.44 lb. per b. hp. hr. Engine can

Automatic or manual control; battery-charging or non-battery units. Other units 800 watts to 25 kw., 110-220 volts a.c. or d.c. and 32 d.c.—*Kohler Co., Kohler, Wis.*



Trap With Thermostatically Controlled Bucket Vent

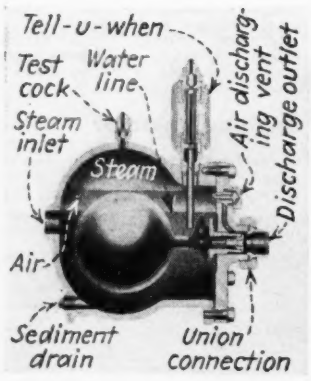
Automatic air bypass to promote quick heating, integral with Armstrong inverted-bucket steam teap. This bucket has large auxiliary air vents closed by flat disk of stainless steel on end of a metallic strip riveted to bucket cap. As long as trap is cold, disk is held away from vent and air escapes rapidly. When steam reaches trap, thermic strip seats disk, and prevents steam from escaping through auxiliary vents.—*Armstrong Machine Works, Three Rivers, Mich.*



Inverted-Bucket Steam Trap

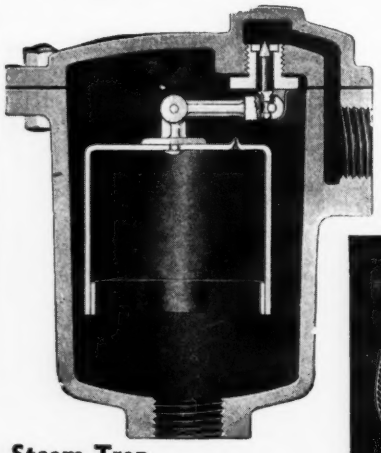
"Bundy Junior" non air-binding trap is adaptable as a flood trap. Thermally operated, thus requiring no thermostatic traps. All parts renewable without disturbing connections. Sizes ¾ to 2 in., in capacities 3,385 lb. of water per hr. at 5 lb. pressures, to 34,680 lb. at 200 lb. pressure. —*Bundy Steam Trap Co., Nashua, N. H.*

Steam Traps



Steam Trap

Model F has three new elements, "Tell-U-When," which indicates if valve is wire drawn and wasting steam; air vent, which prevents air binding, and union connection, which permits replacing of valve and seat in 3 min. Smallest traps handle 2,600 lb. per hr. at 40-lb. pressure, largest handle 24,000 lb. at 40-lb. pressure. Pipe sizes, ½ to 2-in.—*J. E. Swendeman, Inc., 171 Camden St., Boston, Mass.*

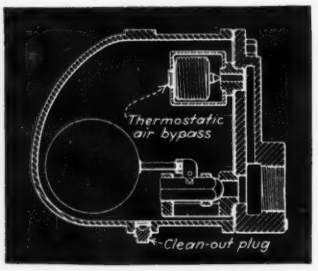


Steam Trap

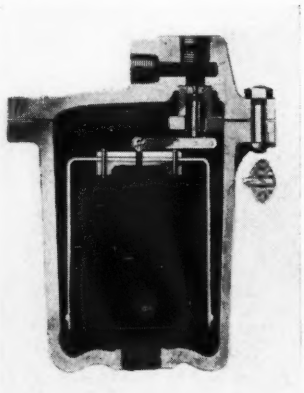
Marsh No. 500 inverted-bucket trap will handle considerable volumes of condensate. Self venting. All pipe connections to body, top can be removed without disturbing piping. Working pressures to 125 lb. per sq.in. Three sizes, ½, ¾ and 1 in.—*Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill.*

Float and Thermostatic Trap

Handles condensation in large quantities and in sudden rushes



as in unit heaters, pipe coils, etc. 1½-in. inlet and outlet, both in front and 3 in. apart vertically. All working parts accessible without disturbing pipe connections. Three pressure ranges, 0-10, 10-60 and 60-150 lb., all with automatic air bypass.—*Sarco Co., 183 Madison Ave., New York, N. Y.*



Steam Traps

80 Series inverted - bucket traps have new method of retaining seat in place and anti-balancing device. Seat forced against gasketed surface by bracket held against cover by two stud bolts. Anti-balancing device consists of valve arrangement on bucket which automatically varies air vent during cycle of operation. — *Strong, Carlisle & Hammond Co., 1392 West Third St., Cleveland, Ohio.*

LUBRICATION—

New Theory and Practice

(Continued from Page 687)

heating of the oil film in a steady state of shear as determined by the relative speed of the surfaces, and by their respective temperatures, and by the thermal conductivity and the viscosity of the oil as related to temperature, without consideration of pressure gradients, or of the influence of a supply of cool oil.

For those who have to do with lubrication problems where wide ranges of temperatures are experienced, such as in northern climates, "Actual Service Testing of Journal Lubrication," by Robert Job, and "Properties Necessary for an All-Year Car Oil," by C. M. Larson, will be of interest. Although these papers treat of lubrication practice in railroad service, they contain valuable suggestions for those who have to deal with lubricating problems of any kind where wide ranges of temperatures are experienced. The paper by Mr. Job gives the properties of several "year-round" oils which have been in practical service on an extensive scale on the Canadian National Railway.

These trials indicate that, in order to be satisfactory under northern summer conditions, a viscosity of at least 50 sec. Saybolt universal at 210 deg. F. is necessary. On the other hand, to meet winter conditions, the oil should remain fluid, or nearly so, even when chilled to —30 deg. F., without preliminary heating of the oil.

Extensive trials of oils of widely different properties lead to the conclusion that reliance under conditions of extreme cold may not be based solely upon viscosity, since a paraffin-base oil with relatively low viscosity, by the A.S.T.M. chart projected to —30 deg., proved unsatisfactory in service, while far better results were obtained with oils with much higher viscosity at —30 deg. F.

VISCOSITY MEASUREMENTS

FOR THE same bearing construction and load, best operating viscosity of lubricating oil decreases as the speed of revolution increases. Because of this, the present trend toward increased internal-combustion engine speed leads to lower operating viscosity. Research of operating conditions at such low viscosity has been hampered by lack of adequate testing means. Attention was called to this condition in "Errors and Corrections in Viscosity Measurements," by W. J. Albersheim, H. S. Konheim, and C. M. Larson. In the authors' opinion it is impractical to tie up measurement of viscosity with measurement of an elapsed time. Investigations indicate that present standard calibration of the Saybolt instrument is correct only for viscosities higher than 60 sec. A new calibration formula has been developed, believed to be practically correct for viscosities as low as 40 sec., which probably covers a range encountered in present engine design.

A new method of testing bearing metals that reproduces wear under service conditions, and gives variations in rate of wear with unit pressure, was described in "Investigating the Importance of Bearing Metal," by J. R. Connelly. This method of testing may be used to investigate the effects of physical proportions, composition and crystalline structure of the bearing metals, various lubricants and change in the properties of lubricants, with temperature and pressure, and possibly interrelations of some of these variables.

HEAT TRANSFER

(Continued from Page 694)

with heat inputs of 90,000 B.t.u. per hr. over a vertical tube having 3.5 to 4 sq.ft. of heating surface located above a furnace having a temperature of 3,000 deg. F. and with 925-deg. mercury vapor inside the tube. In ordinary practice the heat input is kept below this figure. Sufficient evidence is available to indicate quite definitely that with proper design calorized carbon-steel tubes are satisfactory up to vapor temperatures in the neighborhood of 900 deg. F. with a corresponding pressure of about 80 lb. per sq.in. gage. Carbon-steel tubes uncalorized may be used for vapor temperatures up to about 750 deg.

Condensation of mercury should yield somewhat better heat-transfer results than the condensation of liquids that wet the metal surface. At the beginning of a condensing process, only vapor is present, the resistance to heat transfer from the vapor to the cold surface is practically zero, and a high rate results. As condensation proceeds, there is a tendency for a film of condensate to collect. For some liquids this film may be fairly thick and may interpose considerable resistance, but this is not the case with mercury which does not wet the surface.

DISCUSSION

W. J. King pointed out that the presence of air in an actual condenser allows the tube to be filled with water without severe expansion strain. He said that in actual condensers, where heat is transferred from mercury vapor to tubes containing the water, the coefficient of heat transfer varies from 1,000 to 2,000. Where the heat transfer is from superheated vapor to water, the heat-transfer coefficient varies from 5 to 10.

HEAT-TRANSFER RATES IN HEATING AND VENTILATING

F. C. HOUGHTON pointed out that in this field almost every type of heat transfer at widely varying rates is involved. Although thermal engineering is the dominant factor, other considerations including the comfort, convenience and general satisfaction of the occupant of the space conditioned and the first cost of the plant frequently demand greater attention in the design of equipment than efficient heat generation, transfer and utilization.

The paper gave a resume of heat-transfer practice in steam and hot-water heating boilers and warm-air heating furnaces as well as the transfer rates from steam or hot-water heating units. Practical usage no longer recognizes rates of heat emission in B.t.u. per sq.ft. of actual surface for steam and hot-water radiators. A unit heat-emission rate of 240 B.t.u. per hr., called "an equivalent square foot of direct radiation," has been recognized, but this unit is now rapidly giving way to a direct expression of the rate of heat emission of the unit in B.t.u. per hr. or in thousands of B.t.u. per hr.

HEAT TRANSFER IN REFRIGERATING AND AIR COOLING

IN THIS PAPER, W. J. King and W. L. Knaus discussed the status of some more significant heat-transfer processes in the refrigerating field, and called attention to contributions on the subject that may not be familiar and generally accessible to most engineers. It is concerned with heat transfer under the conditions of free convection, forced convection, evaporation and condensation.

Although the process of heat transfer by free or natural convection is well understood, the general formulas given for the film coefficient h are usually too cumbersome for convenient use. For conditions common to the field of refrigeration, the authors have found the following empirical formulas to be entirely adequate for practical purposes: For vertical plane surfaces, the coefficient may be found from

$$h = 93\left(\frac{T}{L}\right)^{\frac{1}{4}}$$

where h is the film coefficient in B.t.u. per hr. per sq.ft. per deg. difference in temperature; T is the temperature difference, and L is the height in feet. Convection from a heated horizontal surface facing upward is about 30 per cent greater and facing downward 30 per cent less than in the vertical position. If the surface is cooler than the air, just the reverse is true.

For vertical or horizontal pipe in still air, the equation becomes $h = 0.42\left(\frac{T}{d}\right)^{\frac{1}{4}}$

where d is the pipe diameter in inches.

Convection coefficients for air flowing over various surfaces are given by curves in the paper, and are based on a considerable number of data selected from various sources in the literature.

In the case of finned tubes, the published data on the air surface coefficients are extremely scarce and inadequate. In general, the indications are that finned-tube coefficients are approximately the same as those for plain tubes and vary in about the same manner with air velocity and tube diameter.

So long as the temperature of the cooling surface does not go below the dew-point of the air, the effect of humidity upon the convection coefficient is negligible. On the other hand, when the air is dehumidified as well as cooled, the latent heat of condensation is added to the sensible heat transferred. Although the condensation of moisture is governed by the vapor-concentration difference, it has been shown that the effect of the latent heat may be included in a total heat-transfer coefficient, the equation for which is given in the paper.

For liquids boiling without forced circulation, the coefficient increases rapidly with the temperature difference. It seems to be due to more rapid circulation of the liquid as the boiling becomes more vigorous with increased temperature difference. Where a rapid rate of circulation is maintained by mechanical or other means, the coeffi-

cients are found to be high and but little affected by the temperature difference between surface and liquid.

Where conditions are such that the liquid superheats easily, the coefficients are likely to be low and the evaporation erratic.

The condition of the surface is also of great importance, roughened or grooved surfaces leading to higher coefficients than those obtained with smooth polished surfaces. Curves in the paper show representative evaporation coefficients of water and methylene chloride.

Discussion

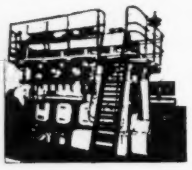
G. L. Tuve pointed out that the condition and direction of approaching air in the case of finned tubes had a very material effect on the heat transfer. Differences of as much as 50 per cent have been found.

TESTING INSULATING BLOCKS

A paper not on the original program, by C. E. Weinland, described a method for testing high-temperature insulating blocks. The method employed two electrical heaters and a heat meter somewhat similar to that developed by P. Nicholls. One of the heaters was used to calibrate the heat meter, and the other to raise the one face of the test samples to temperature of 2,600 deg.

In answer to a question regarding the relative bearing capacity of insulating brick at elevated temperatures, the author replied that because of the lower density of the insulatd bricks they would support a wall of the same height as refractory brick.

NEW BULLETINS



Motor Starter—The Electric Controller & Mfg. Co., 2696 East 79th St., Cleveland, Ohio. Two new folders; 6 pages on No. 1 Type ZO motor starter, and 6 pages on Type A safety switches.

Flexible Couplings — Farrel-Birmingham Co., Inc., 437 Vulcan St., Buffalo, N. Y. 8-page bulletin No. 437, Farrel Gearflex flexible couplings.

Water-Treating Units—Dearborn Chemical Co., 310 S. Michigan Ave., Chicago, Ill. 12-page bulletin, Dearborn water-treating units and treating equipment.

Welding Flanges—Tube-Turns, Inc., 1300 South Shelby St., Louisville, Ky. Bulletin 404, descriptive information on Tube-Turns and welding flanges, tees, etc., gives dimensional and engineering data and price lists.

Recording Gages—The Foxboro Co., Foxboro, Mass. 4-page bulletin on Foxboro all-steel spring recording gages.

Volute Pumps — Morris Machine Works, Baldwinsville, N. Y. Bulletin 150, Morris double-suction high-speed pump.

Starter — Dominion Engineering Works, Ltd., Montreal, Canada. 8-page bulletin, Bethlehem snub starters applied to motor drives.

Power Plant Equipment—Rockford Power Machinery Co., 627 Seventh St., Rockford, Ill. 8-page folder on rebuilt power-plant equipment.

Iron Valves—The Edward Valve & Mfg. Co., Inc., 1200 West 145th St., East Chicago, Ind. Section L of Catalog No. 11 shows complete line of Ferac high-strength iron valves. Pressures up to 250 lb.

Thermometers and Pressure Gages—Brown Instrument Co., Philadelphia, Pa. New Brown Thermometer and Pressure Gage Catalog No. 6702, 80 pages.

Metal Coating—Metals Coating Co. of America, 495 N. Third St., Philadelphia, Pa. Bulletin No. 1201, metal coating by means of MetalLayeR process.

Pressure Instruments—The Foxboro Co., Foxboro, Mass. 40-page Bulletin No. 185, complete line of Foxboro pressure recording, controlling and indicating units.

Steam Storage—Ruths Steam Storage, Inc., 270 Madison Ave., New York, N. Y. 20-page bulletin describes Ruths steam-storage system.

Boiler Furnace Brick—The Norton Co., Worcester, Mass. 4-page bulletin, "Handling Heat," No. 2, Crystolon high-temperature brick, particularly in boiler furnace walls.

Liquid Level Controllers—Kieley & Mueller, Inc., New York, N. Y. Bulletin C, liquid level control in tanks, pipe lines, condensers, hotwells, feed-water heaters and other vessels.

Condenser Tubes — Scovill Mfg. Co., Waterbury, Conn. 19-page booklet, "Condenser Tube Installation Methods and Ferrule Price List," data on all types of outlet ferrule.

Water Filters—Graver Tank & Mfg. Co., 332 South Michigan Ave., Chicago, Ill. New bulletins, 8-page, horizontal and vertical pressure type water filters; 24-page, swimming pool filters; 6-page, brewery tanks and equipment; 12-page, distillery tanks and equipment; and 4-page, elevated steel tanks.

Screws and Bolts—Pheoll Mfg. Co., 5700 Roosevelt Ave., Chicago, Ill. 104-page, 1934 catalog, information on screws, bolts, nuts and allied products, also reference tables on American National Standard screw threads and tolerances.

Motors and Generators—Crocker-Wheeler Electric Mfg. Co., Ampere, N. J. 12-page bulletin, motors, generators and motor-generator sets, etc.

Chromium Steel—Republic Steel Corp., Central Alloy Div., Massillon, Ohio. Form ADV. 220-B, data on Enduro 4-6% chromium steels for resistance to corrosion, acid attack and scaling at elevated temperatures.

Reducing and Regulating Valves — The Strong, Carlisle & Hammond Co., 1392 West Third St., Cleveland, Ohio. Bulletin No. 152, Strong reducing and regulating valves and quick-cleaning strainers.

Thrust and Journal Bearings—Kingsbury Machine Works, Inc., 4316 Tackawanna St., Philadelphia, Pa. 60-page Bulletin G-1, "Marine-Type and Heavy Industrial Mountings—Kingsbury Thrust Bearings and Journal Bearings," standard thrust bearing and journal bearing mountings for horizontal shafts, ranging from 2⅜ to 23¼ in. in diameter.

Pipe and Tubing—The Babcock & Wilcox Tube Co., Beaver Falls, Pa. 12-page Bulletin T-7, "Diescherized Pipe & Tubing," new class of seamless tubular product made hot finished.

Temperature Control—Bausch & Lomb Optical Co., Rochester, N. Y. 4-page bulletin on Constant Temperature Control for use with refractometers, calorimeters, water baths and hot stages.

Industrial Instruments — Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa. Two bulletins, one "Hundreds of Dollars Saved by Analyzing Chart Records," and the other, "15% Fuel Saving," by CO_2 records.

Compressors—Worthington Pump & Machinery Corp., Harrison, N. J. 8-page Bulletin L-611-S6B, single-horizontal, single-stage, steam- and motor-driven compressors; and 16-page Bulletin L-600-B2, compressors equipped with feather valves for refrigeration; single-page folder on Worthington-Gamon Beer Meters.

Indicating Lamps—General Electric Co., Schenectady, N. Y. 4-page GEA-1804, new indicating lamps complete with receptacles, resistors and color caps.

Stokers—James Beggs & Co., Inc., 165 Broadway, New York, N. Y. 8-page bulletin, McHose Underfeed Ram-Type Stoker.

Westinghouse — Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Catalog 282, 16 pages, "Electric Water Heaters," Leaflet 20593, "Fluid Valve," 12-page C.1959-A, gas-electric sets from 800 watts to 100 kva.

Oil Burner Units—Cleaver-Brooks Co., Milwaukee, Wis. 6-page bulletin, "Oilbuilt Boiler-Burner Units," specifications, typical installations and data.

Bearing Lubrication—The Pure Oil Co., Chicago, Ill. Mechanical Bulletin No. 57, "Lubrication of Bearings," 50 pages, unusually complete data on bearing oiling.

Filters—Hungerford & Terry, Inc., Clayton, N. J. Bulletin No. 23, "Hungerford Air-Water-Wash Gravity Filter."

Commutators and Slip Rings—Columbia Electric Mfg. Co., 1292 East 53rd St., Cleveland, Ohio. Bulletin, describes company's manufacturing and repair services for commutators and slip rings.

Chains and Sprockets—Diamond Chain & Mfg. Co., Indianapolis, Ind. Catalog 583, 96 pages, data on selection, application, calculation formula and 60 pages of tables on chain and sprocket data; also information on special chains.

Compressors—Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin L-600-B3, vertical duplex-type refrigeration compressors. Bulletin L-622-S1, specifications on vertical-duplex type units. Bulletin S-550-S5, vertical 4-cycle, 180 to 360-hp. gas engines. Bulletin D-316-S1, vertical Freflo type centrifugal pumps for sewage, sump and drainage. Bulletin W317-S1A, horizontal Freflo type pump for sewage and liquids containing solid matter in suspension.

Pumps—Chain Belt Co., Milwaukee, Wis. 16-page catalog, Bulletin No. 240, Rex Speed Prime Pumps. Includes engineering data and simplified charts and tables.

Thermometer and Pressure Gage—Brown Instrument Co., Wayne and Roberts Aves., Philadelphia, Pa. 8-page folder announcing new recording thermometer and pressure gage.

Feeder-Voltage Regulator—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 3021, 4 pages. Automatic feeder voltage regulator recently described in Power.

Condensation Return Unit—Decatur Pump Co., Decatur, Ill. Bulletin No. 101, Series 4700 Condensation Return Unit.

Thermostatic Trap—Barnes & Jones, Inc., 128 Brookside Ave., Jamaica Plain, Mass. 4-page bulletin, B.& J. Thermostatic Traps.

Traps and Valves—Hoffman Specialty Co., Inc., Waterbury, Conn. Folders, Hoffman traps and valves; gives engineering data.

Remote-Control Switches—Hart Mfg. Co., Hartford, Conn. Bulletin No. 10-A, "Remote Control Equipment," specifications and installation data.

Automatic Steam Generation—Steam & Combustion Co., 1559 Sheffield Ave., Chicago, Ill. 8-page folder "SteCom at a Century of Progress Exposition," data on three automatic steam installations at World's Fair.

Flow and Pressure Controls—Northern Equipment Co., Erie, Pa. 16-page catalog, "The Copes Catalog of Flow Level and Pressure Control," engineering data and specifications.

Stainless-Clad Steel—Ingersoll Steel & Disc Co., a division of Borg-Warner Corp., Chicago, Ill. 4-page folder, IngOclad stainless-clad steel.

General Electric—General Electric Co., Schenectady, N. Y. New bulletins include GEA-1754 on Portable Testing Equipment; GEA-1769, Fractional Horsepower, Single-Phase, Repulsion-Start Induction Motors, ¼ to ½ hp.; also GEA-1784 on Portable Instruments.

Small Electric Plant—Kohler Co., Kohler, Wis. 4 models of 800-watt, 32-volt, d.c. units.

Feed-Water Regulators—Northern Equipment Co., Erie, Pa. 40-page Copes catalog on feed-water regulators and allied equipment.

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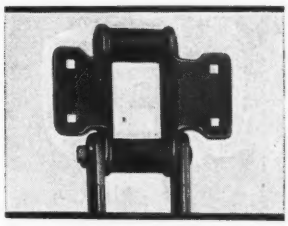

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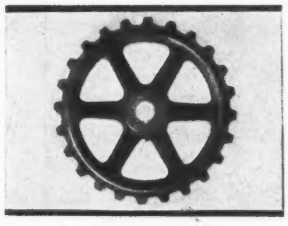

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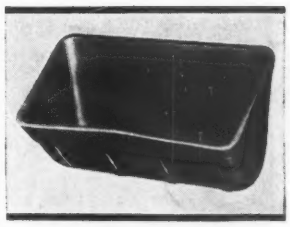

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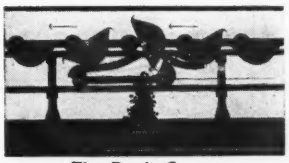

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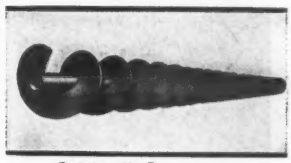
Belt Conveyor Idlers



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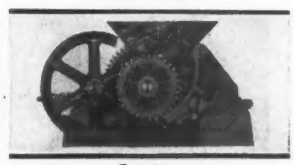

Crushers

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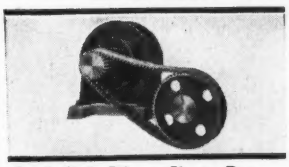
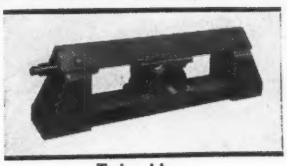
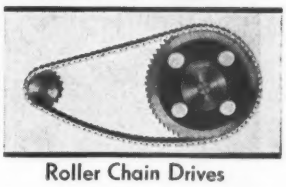


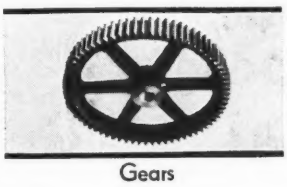
Link-Belt Silent Chain Drives



Take-Ups



Roller Chain Drives



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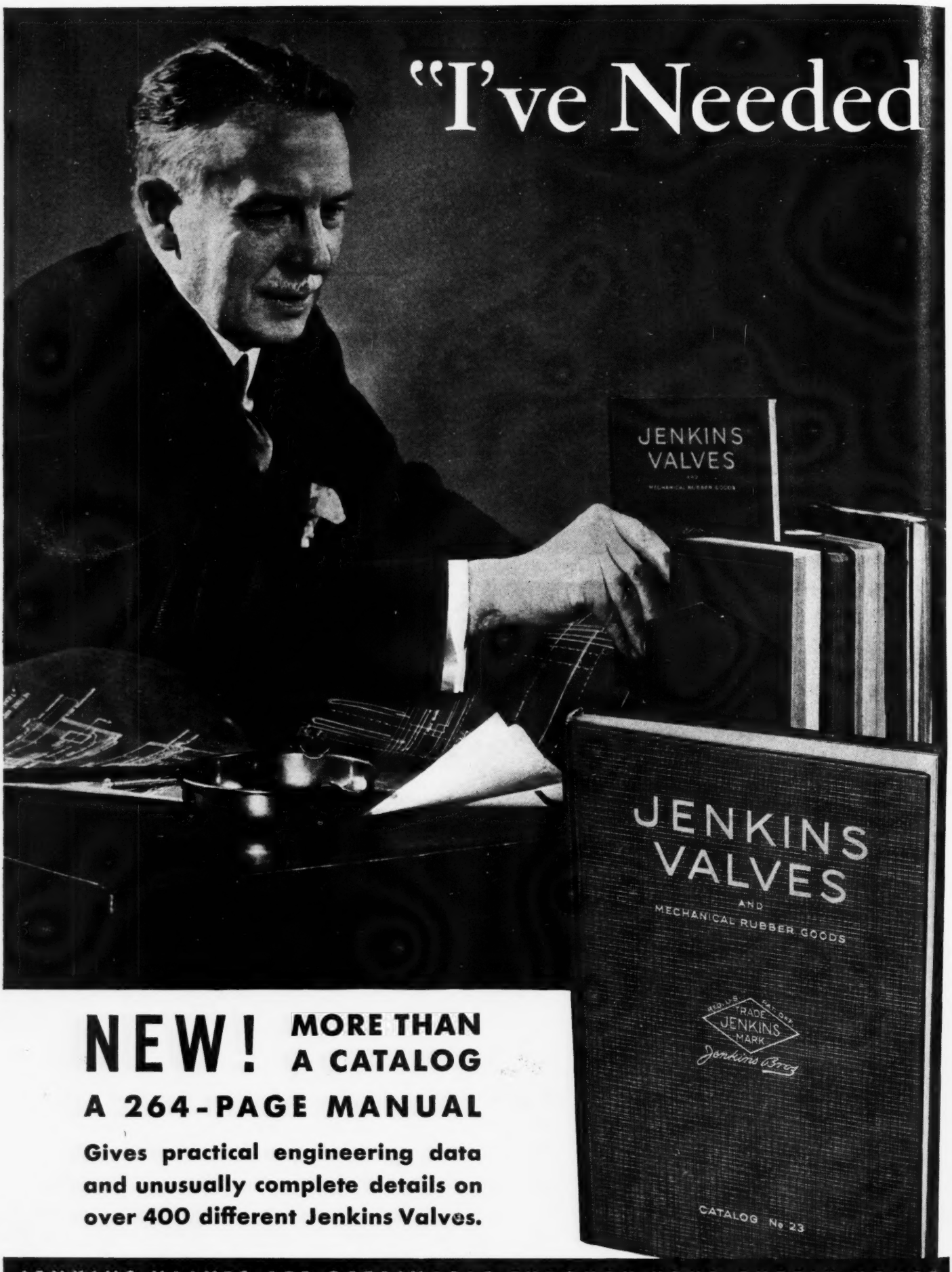

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One of the features which keeps this new Catalog within easy reach of men who must deal with valves is the large Engineering Data Section. This part of the book actually is a well arranged, practical encyclopedia of information constantly needed. More essential data than will be found in any single engineering manual.

Equal praise, though, goes to the section on Jenkins Valves. Praise for the unusually complete description which makes it easier to pick the correct valve for a job. Praise for the improved indexing which tells at a glance where to find data on any one of *more than 400 different Jenkins Valves.*

Keep the new Jenkins Catalog handy. It will save you time and money. For any Jenkins Valve you may select is made for a lifetime of economical service...made so good that it is backed by—

A FAIR OFFER—*If you will put a Jenkins Valve to a service test on the worst place you can find, where you cannot keep other valves tight, and if it is not perfectly tight, or does not hold steam, oils, acids, water or other fluids, longer than any other valve, you may return it and your money will be refunded.*

JENKINS BROS., 80 White Street, New York, N. Y.; 510 Main Street, Bridgeport, Conn.; 524 Atlantic Avenue, Boston, Mass.; 133 North Seventh St., Philadelphia, Pa.; 822 Washington Boulevard, Chicago, Ill.; JENKINS BROS., Ltd., Montreal, Canada; London, Eng.

Jenkins Valves

BRONZE · IRON · STEEL SINCE 1864

NRA MEMBER U.S. WE DO OUR PART

A FEW OF THE HUNDREDS OF JENKINS VALVES IN THE NEW CATALOG

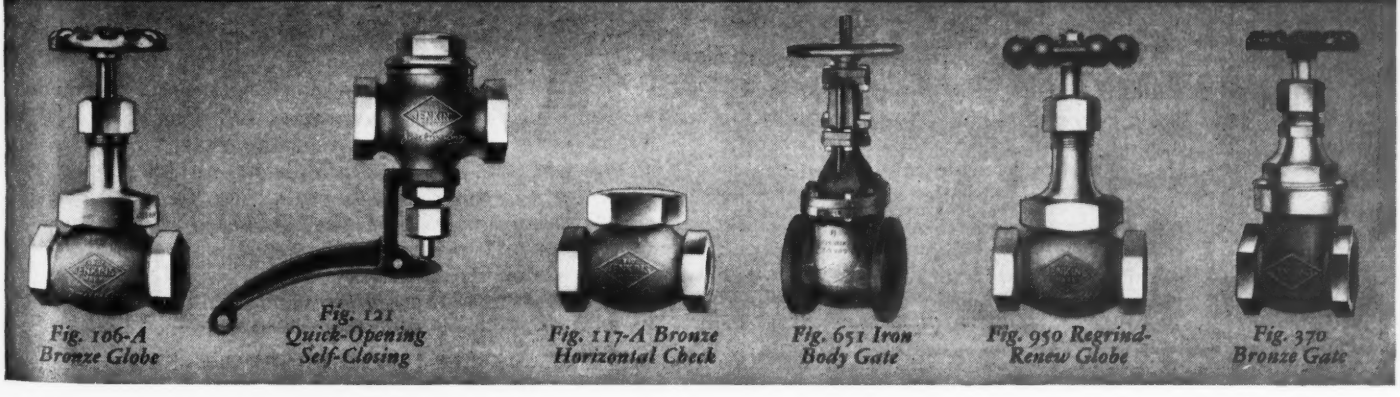
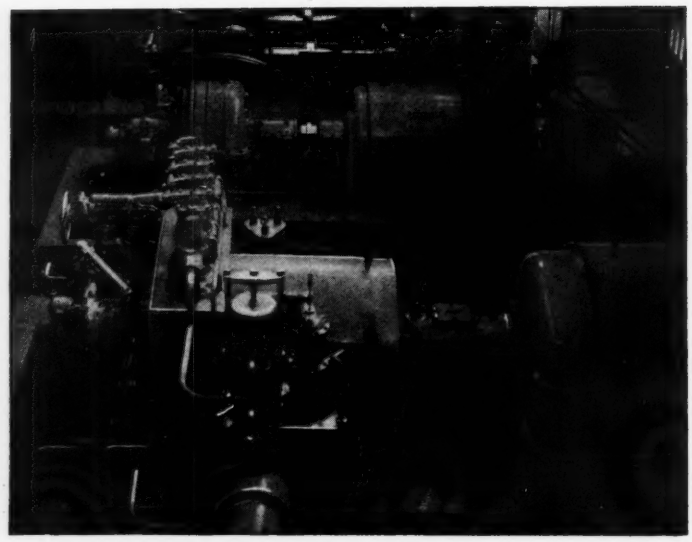
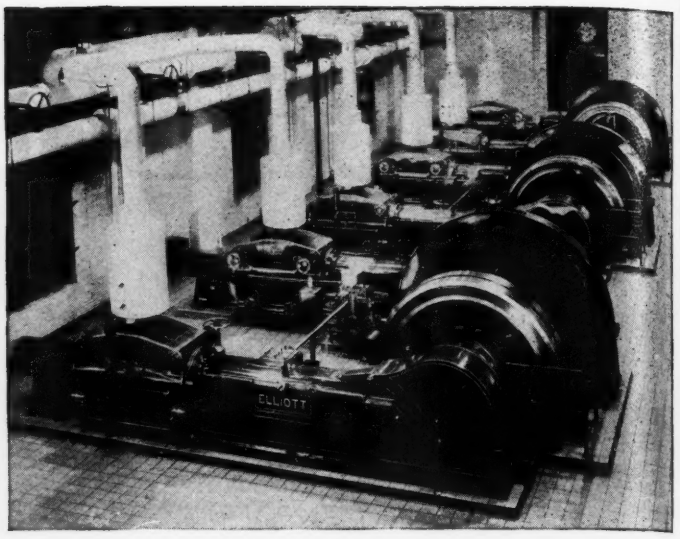


Fig. 106-A Bronze Globe — *Fig. 121 Quick-Opening Self-Closing* — *Fig. 117-A Bronze Horizontal Check* — *Fig. 651 Iron Body Gate* — *Fig. 950 Regrind-Renew Globe* — *Fig. 370 Bronze Gate*



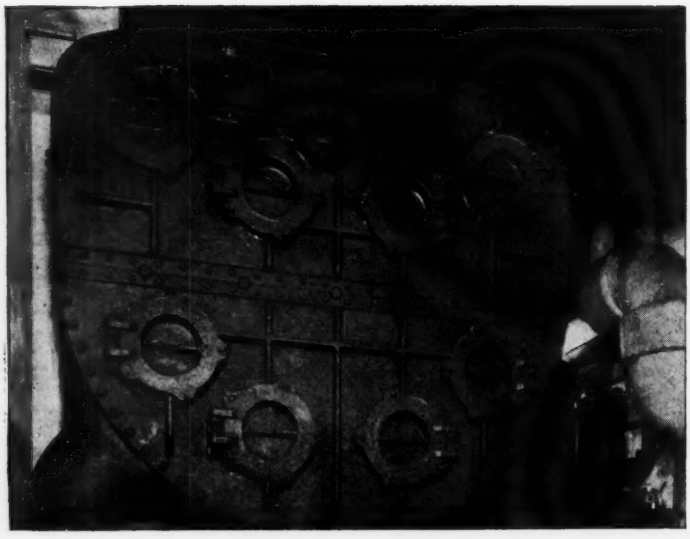
ELLIOTT TURBINES

The proper type of turbine-generator can pay for itself in an industrial plant in a short while. Elliott turbines are built in all the necessary types and in a range of sizes covering the needs of most power plants. Elliott builds complete turbine-generator units, generator along with the turbine. A full line of mechanical drive turbines. The reliability of Elliott turbines is an extra economy.



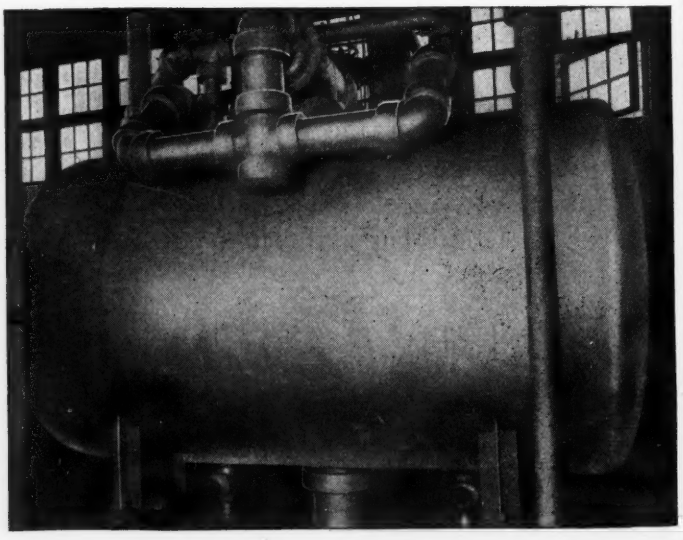
ELLIOTT ENGINES

A steam engine can be furnished to suit your heat balance and exhaust steam requirements. Elliott builds single-valve, four-valve and unaflow engines, and gives unbiased recommendations between these types, also in comparison with turbines. Elliott builds the generator along with the engine to make a completely coordinated engine-generator unit. Also engines for driving compressors, etc.



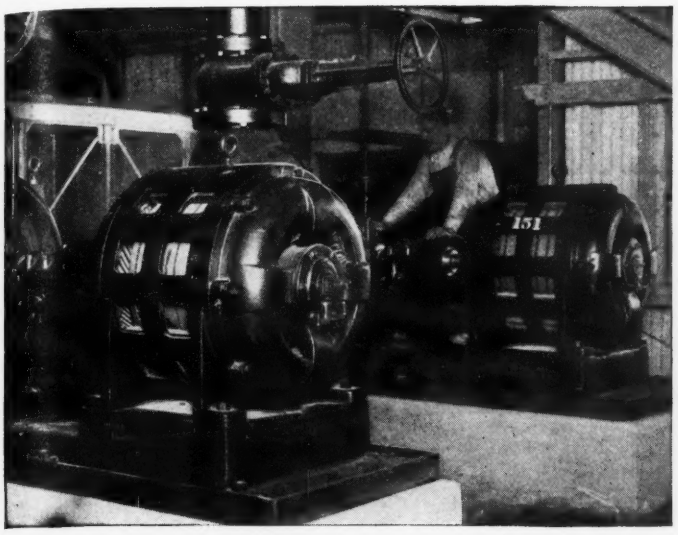
ELLIOTT CONDENSERS

Elliott condensers are designed for maximum condensing effect, low pressure drop and hot deaerated condensate. Flexible design permits a wide range of modifications to fit the condenser to operating conditions and to obtain highest possible economy . . . Elliott ejectors have been exhaustively developed not only for power plant condensers but for use in all sorts of industrial vacuum processes.



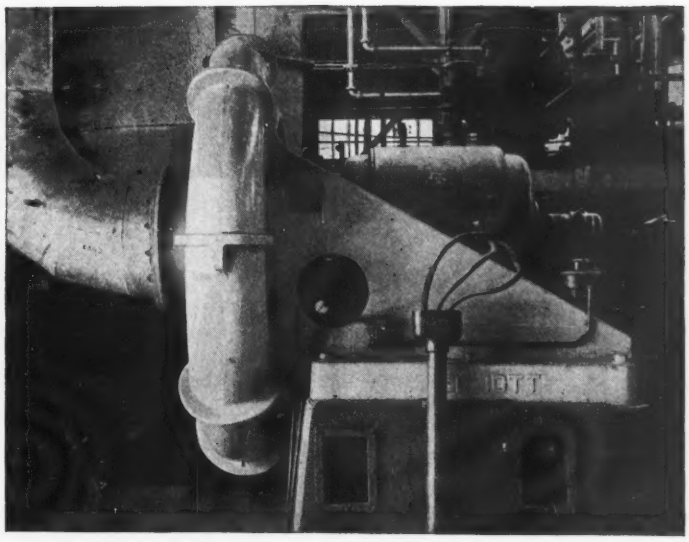
ELLIOTT DEAERATORS

Elliott Company pioneered deaeration. Elliott deaerators and deaerating heaters not only pay for themselves in preventing corrosion in boilers, economizers and piping, but they also give the most efficient possible feed water heating. They heat up to steam temperature and deaerate down to zero oxygen. Built in all sizes, and designs are so flexible that they may be adapted for any condition.



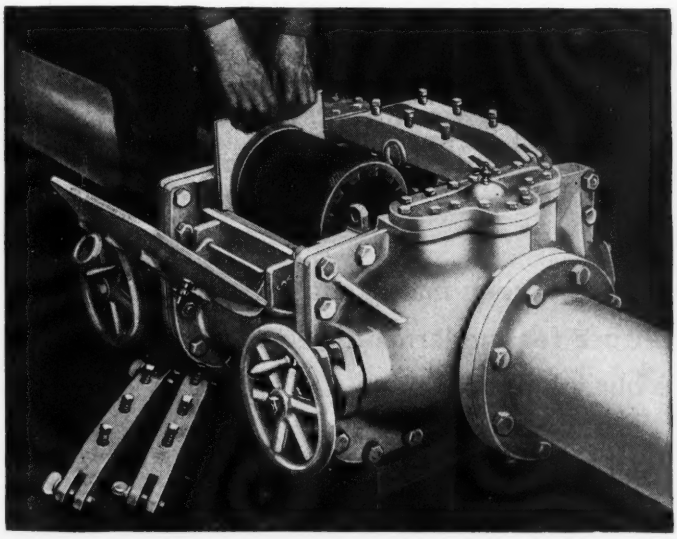
ELLIOTT MOTORS

Elliott electrical machinery includes generators built as units with turbines and engines; also a complete line of motors and motor-generator units above 50 hp. In large high-speed motors Elliott engineers have exceptional experience. Elliott motors are tailor-made to the job for which they are selected—and they have been selected for some very tough and out-of-the-ordinary applications.



ELLIOTT BLOWERS

Where the job requires a real blower, Elliott centrifugal units fill the bill. Ruggedly constructed, Elliott blowers are not glorified fans, but are made for real service in gas plants, chemical plants, etc. One of many distinctive features is the radial blade open impeller of one-piece construction, with no riveting or brazing and no corners to collect deposits. It can be made of material suited to the service.



ELLIOTT STRAINERS

The cheap protection of reliable strainers saves costly repairs. It is wise economy to install a Twin Strainer and save a pump from very probable damage. Twin Strainers give continuous, uninterrupted protection. You clean one side while the other is in operation. Elliott also builds single strainers of solid construction equaling that of Twin Strainers.

Q-1009

Power equipment of
ONE STANDARD
of DESIGN and of
QUALITY . . . . .
and undivided
responsibility in
its manufacture

ELLIOTT
COMPANY
PITTSBURGH, PA.
Works and Sales Headquarters
JEANNETTE, PA. and
RIDGWAY, PA.

District
Offices in
Principal
Cities

Mr. Engineer ....

We Have a

We have to sell your management the idea that modernization is advisable *because it is profitable.*

We have to prove that obsolete equipment is reducing your plant efficiency.

We want to present figures and facts so exact and so convincing that your executives and their directors simply can't turn down your modernization plans.

We know good practice. We know what is going on in our field. *You* know wherein lie the weaknesses in your plant and you no doubt have formed some pretty definite plans to correct them.

We want to go with you to your management with plans calling for an expenditure for modernizing equipment. It must be done and it is our job to do it.

We can't go unprepared. We must have facts, well formulated plans, proofs. Even then we will find resistance aplenty. But no management can think less of us if we can show how to save money.

AMERICAN

AMERICAN ENGINEERING COMPANY, ARAMINGO AVENUE, PHILADELPHIA, PA.

Selling Job to do

Stokers are only one item in the modernization plan. They alone can't cure all the troubles of high steam costs. But they are important—the savings they make are important savings.

We make stokers. We know stokers—what they can do—what they can save. And if you will help us to prepare a modernization plan to present to your management, we'll be glad to cooperate with you.

We'll make the necessary studies to prepare dependably accurate cost and savings figures on modern stoker equipment. Figures based on knowledge, experience and past performance.

Please feel no hesitancy in asking for such assistance. You'll be obligated in no way. The preparation of estimates is one of the duties of our engineering department—one of the reasons why we maintain a large stoker engineering staff.

We repeat, we have a selling job to do. Will you help us?

AMERICAN ENGINEERING COMPANY · PHILADELPHIA

ENGINEERING

IN CANADA: AFFILIATED ENGINEERING CORPORATIONS, LTD., MONTREAL, P. Q.

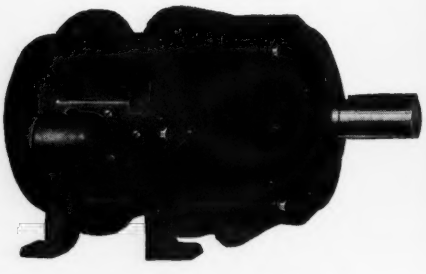
Products

That will make

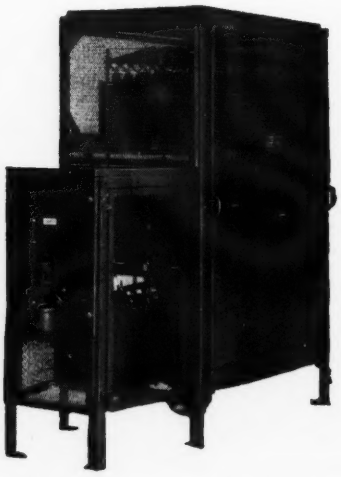
DURING the last year, General Electric has advocated investment in products which, at one and the same time, greatly reduce operating costs and greatly improve your equipment. It has consistently pointed to such products as its Pyranol-treated capacitors for improving the power-factor of plants; to its mechanical-drive turbines, which enable you to get the most out of steam; to its synchronous motors, with their inherent high efficiencies; to its pellet lightning arresters, which reduce the cost of transformer outages; and to its instruments for detecting power losses.

It pays to install apparatus of this character as you enter the new year. Such G-E products enable you to go ahead as you economize. They make modernization profitable.

The reliability of G-E motors is universally recognized. General Electric builds motors and control in sizes and ratings to meet every known application



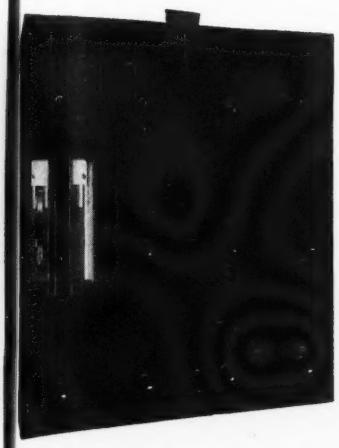
G-E gear-motors, from ¾ to 75 hp., which deliver full-rated horsepower at the output shaft, may be the very drive you need if your speed requirements are between 13 and 600 rpm.



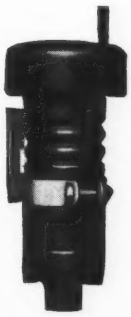
G-E Pyranol-treated capacitors are non-inflammable, efficient, and compact; they make possible unusual economies by improving the power-factor of electric circuits

G E N E R A L

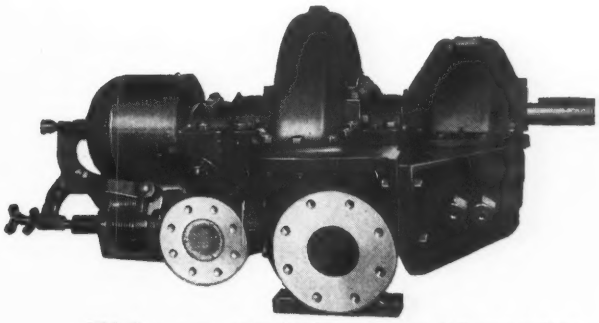
Modernization Profitable



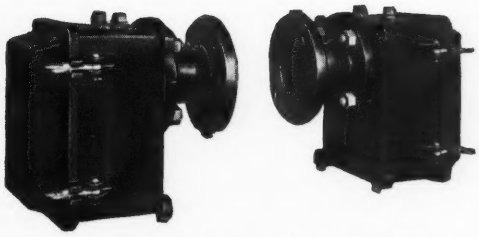
G-E dead-front switchboards have these advantages: small installation expense, low maintenance cost, full protection to service and operators, and they *last!*



You can cut down lightning losses by installing G-E pellet arresters. With their use, you may expect to reach a new low in losses from transformer outages

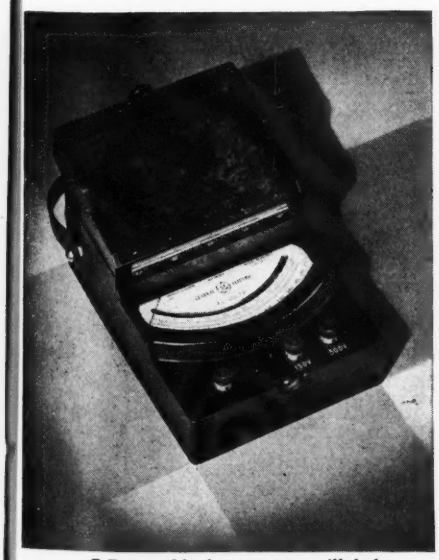


This is a new modernization tool—the G-E gear-turbine, which combines in one unit a standard turbine and a reduction gear. It is the ideal drive for small, low-speed fans, pumps, etc., where steam is required for process work



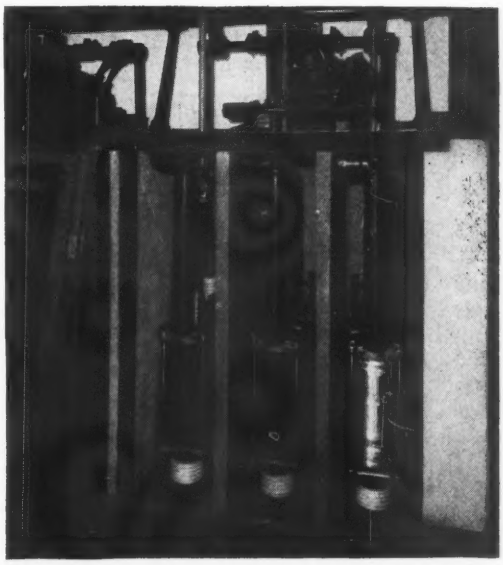
The new G-E photoelectric smoke-density indicators can "monitor" your boilers, warning you of infractions of local smoke-prevention ordinances

Specify G-E oil fuse cutouts. They are reliable—durable—safe



G-E portable instruments will help you make power surveys, and point the way to worth-while savings. They are unsurpassed in accuracy, appearance, and portability—yet are moderately priced

Detailed information covering these products can be obtained from the nearest G-E office, or from Dept. 6-201, General Electric Company, Schenectady, N. Y. Better still, a G-E engineer-specialist will be glad to study your equipment and your requirements, and to give you his recommendations. There is no charge for his services. Just write to the G-E office nearest you.



The interrupting ratings of G-E oil circuit breakers are being doubled and trebled by the addition of the oil-blast features. Oil-blast elements cost less than new breakers

200-793

E L E C T R I C

1877

WHAT MAKES AN INDUSTRIAL ORGANIZATION LIVE?

It doesn't just happen. A company does not continue in the business of building boilers, or any other product, for fifty-six years just by accident.

Dotting the path of progress in boiler design are many Edge Moor milestones—proof of inherent leadership in engineering thought and initiative.

★ The first successful waste heat installation in a cement plant was made by Edge Moor. Today, approximately eighty percent of the world's cement plant waste heat boilers are Edge Moor's.

★ The first pulverized fuel fired boilers for a public utility were designed and installed by Edge Moor.

★ Edge Moor built the first longitudinal boiler with more than two drums, a design soon widely adopted after Edge Moor initiative overcame engineering prejudice.

★ Edge Moor was the father of the single pass boiler and many another first quality pioneer engineering achievement that has since come into general use in the steam generating field.

Back of the Edge Moor Organization are many men's personalities, their whole business lives devoted to making boilers better and building an unimpeachable record for the highest quality and nothing but the best in workmanship and materials.

Today, Edge Moor perpetuates its reputation as a front-rank performer with an organization sensitively attuned to the power requirements of the new era and under the personal supervision of Mr. Ely C. Hutchinson, one of the recognized authorities of our times on trends in modern power development and their economic significance.

1934

THE MODERN EDGE MOOR ★ ★ ★ ★

To all those who value modern qualifications for engineering, building and erecting steam generating equipment, custom built to the particular requirements of each individual power problem—and who respect a company which stands four-square behind its products—Edge Moor, today, offers:

★ Outstanding progressiveness of thought applied with discriminating conservatism.

★ Four acres of fully modernized shops employing advanced equipment and technique for metallurgical research—for the welding of boiler drums and other pressure vessels of steel, chrome and alloyed metals—for X-ray inspection of welds, with equipment capable of looking through 4¼ inches of metal.

★ A wide range of types and sizes of Water Tube Boilers from which a selection or adaptation may be made to suit almost any given set of conditions.

★ An engineering department ready to assist in analyzing special problems—to work with purchaser's engineers for best results.

★ Auxiliary equipment of this company's design and manufacture embracing water walls, air preheaters, superheaters and economizers engineered to assure high overall efficiency of every Edge Moor installation, offering centralized responsibility for all units comprising the complete steam generator.

★ Dependability of service, stability of organization and—

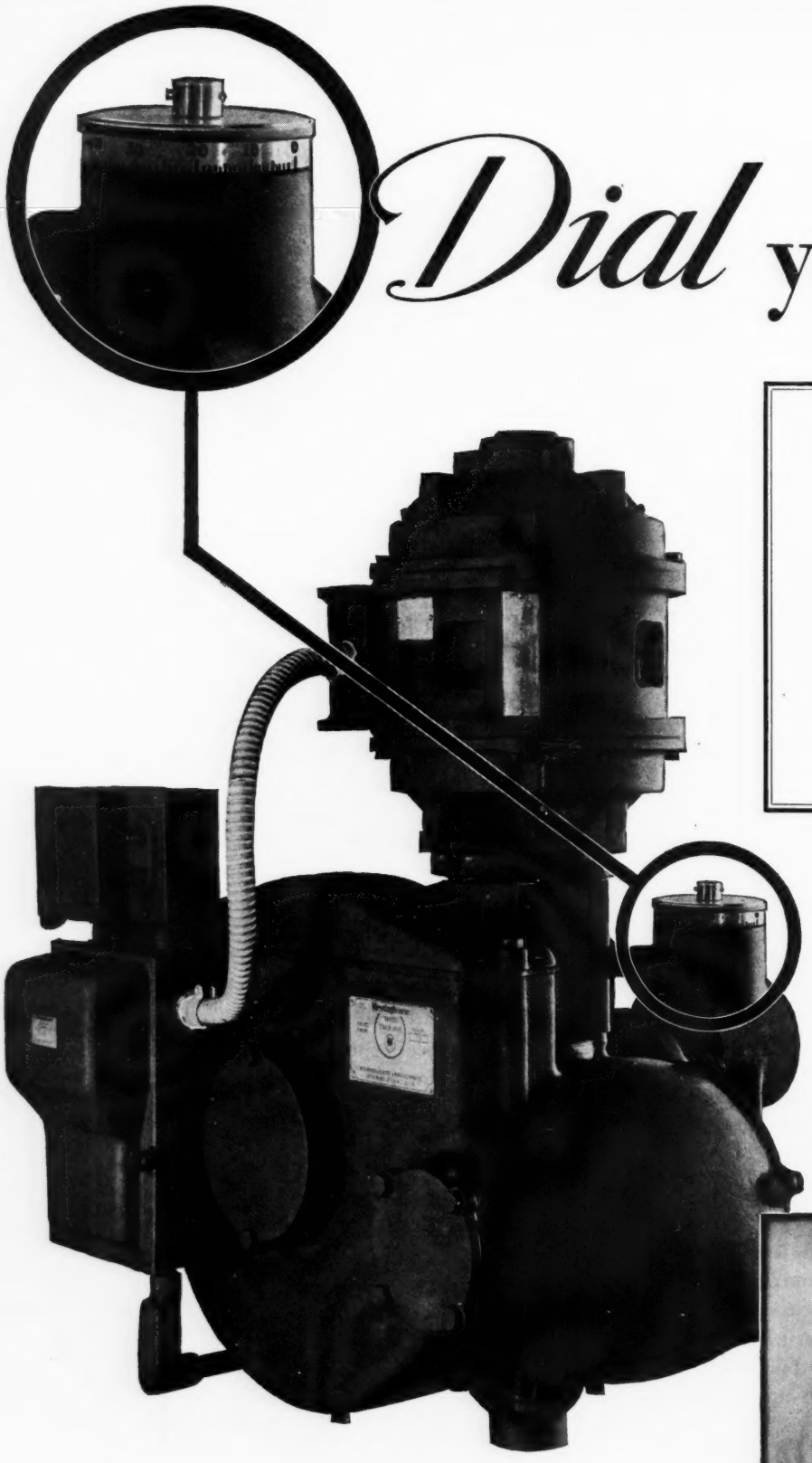
★ Pride of product that considers Edge Moor's reputation on a par with their desire for business.

EDGE MOOR IRON COMPANY

EDGE MOOR, DELAWARE

Builders of all types of Water Tube Boilers and their Auxiliaries . . . Edge Moor Irwin Gas Fired Boilers . . . Class I—II or III Welded Pressure Vessels of Steel, Chrome and other Alloyed Metals.

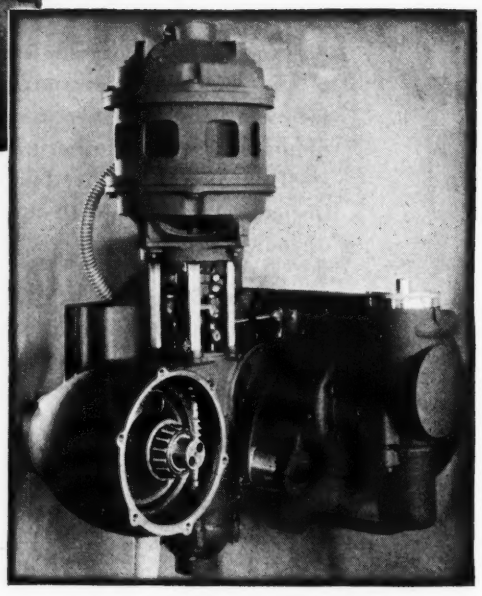
Dial your BEST



Features of Design

Mechanism protected by shearing pin.
Efficient, cut, heat-treated gears.
Timken roller bearings.
Bronze worm wheel.
Forced lubrication.
No stuffing boxes.
Oil and dust-tight.
All parts accessible.

Above—The Varifeed Drive operates the coal-feeding ram for two complete revolutions of the crank at periodic intervals. The Varitor fixes the elapsed time in each interval thus regulating the rate of feeding coal. The motor runs continuously, the drive being engaged or disengaged by a clutch controlled by the Varitor. The Varitor dial, graduated in hundreds of pounds of coal per hour, is set at the desired feeding rate.



Right—Cover plates removed to show cut, heat-treated gears, and shearing pin on the motor drive that prevents overloads from damaging unit.

COAL FEEDING RATE

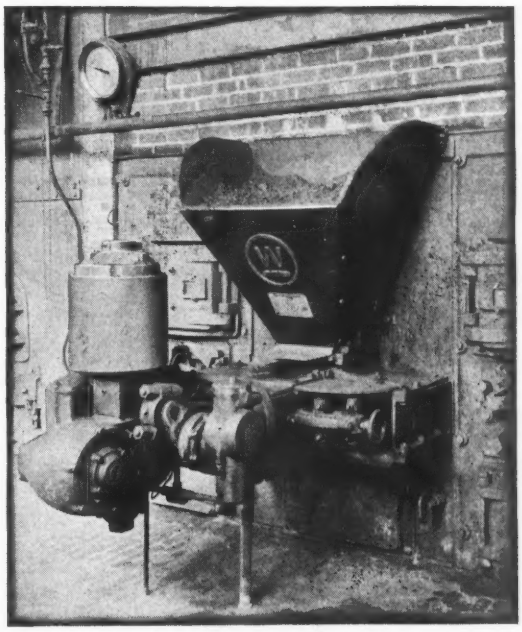
New Varifeed Drive for Single-retort Westinghouse Stokers gives coal-feeding range from 1 to 70

HERE is a new compact drive for Westinghouse single-retort stokers operated by an integrally mounted, direct connected, constant speed a-c. motor.

It makes possible an infinite number of coal-feeding rates to a maximum of 4000 pounds per hour, permitting the selection of the feeding rate best suited to conditions existing at one given time.

It may be adapted for use with either automatic control or manual operation, and is easily applied to any Westinghouse single-retort stoker by unbolting the steam cylinder and bolting the Varifeed Drive in its place.

In addition, it is very economical in its power requirements.



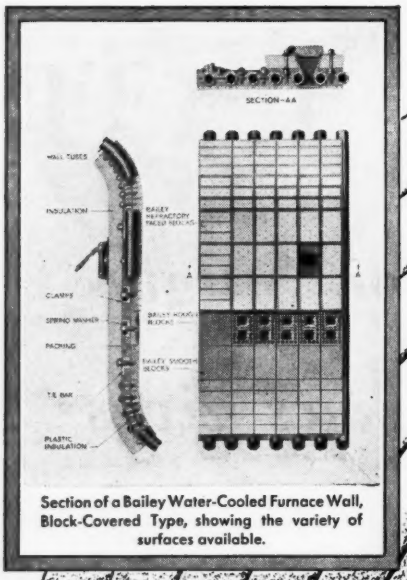
Typical installation showing Westinghouse Single-retort Stoker with Varifeed Drive.

Westinghouse

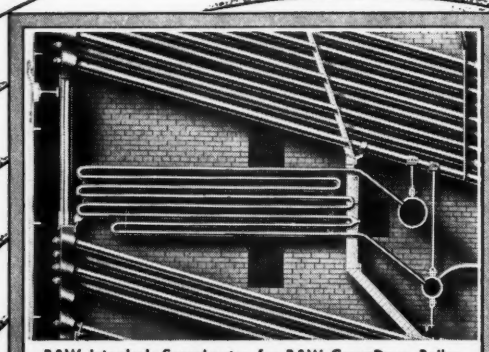
T 79834

Quality workmanship guarantees every Westinghouse product

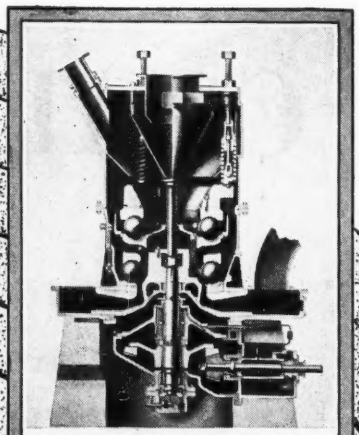
Babcock & Wilcox Boiler



Section of a Bailey Water-Cooled Furnace Wall, Block-Covered Type, showing the variety of surfaces available.



B&W Interdeck Superheater for B&W Cross-Drum Boiler.



B&W Type B Pulverizer for intermediate capacities. Also built in single-and three-row types.

BABCOCK & WILCOX COMPONENT EQUIPMENT

FURNACES
Water-Cooled and Refractory

PULVERIZED-COAL BURNERS
Circular, Intertube, Multiple Intertube, Cross-Tube

OIL BURNERS
Mechanical Atomizing — Standard and Wide Range; Steam Atomizing

COMBINATION BURNERS
Pulverized Coal, Oil, Gas

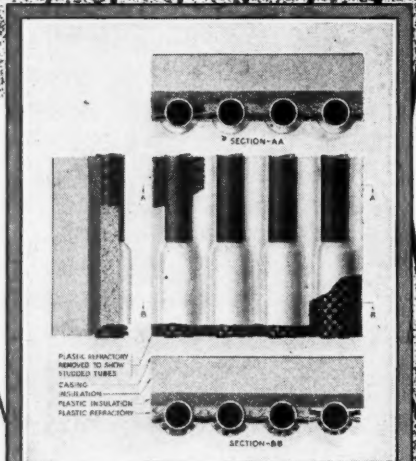
COAL PULVERIZERS

CHAIN-GRATE STOKERS

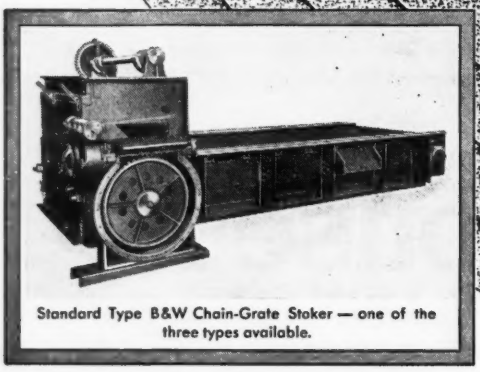
SUPERHEATERS

ECONOMIZERS

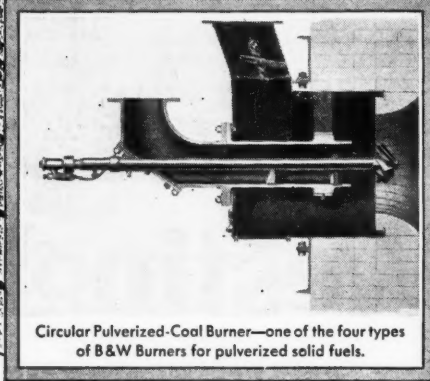
AIR HEATERS



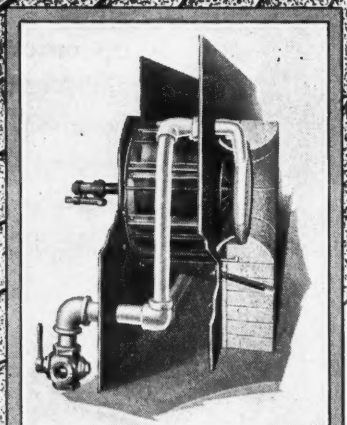
Section of Bailey Stud-Tube Furnace Wall showing refractory-faced and bare tubes.



Standard Type B&W Chain-Grate Stoker — one of the three types available.



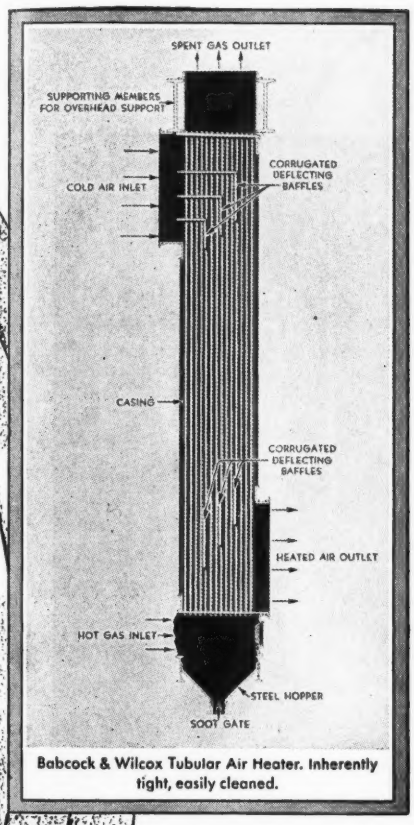
Circular Pulverized-Coal Burner—one of the four types of B&W Burners for pulverized solid fuels.



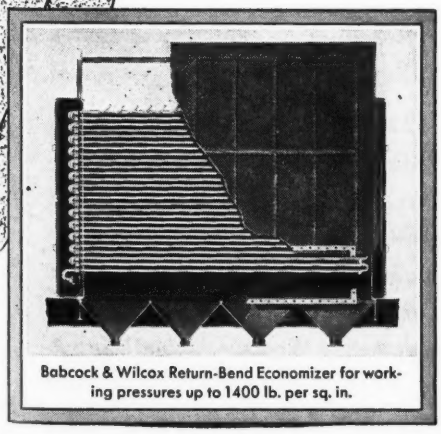
B&W Combination Oil-and-Gas Burner. Steam and mechanical-atomizing oil burners also are available.

Units Are Complete

in Component Equipment



Babcock & Wilcox Tubular Air Heater. Inherently tight, easily cleaned.



Babcock & Wilcox Return-Bend Economizer for working pressures up to 1400 lb. per sq. in.

Babcock & Wilcox Boiler Units are complete in that they are available with all essential component equipment of the Company's own design and manufacture. This equipment includes refractory and water-cooled furnaces; coal pulverizers; burners for pulverized coal, oil, and gas; stokers; superheaters; economizers; and air heaters. The photographs and listing indicate the wide range of types and sizes of such equipment made by Babcock & Wilcox and providing a greater selection in many cases than that available from any other one boiler manufacturer.

The experience gained with combustion problems by B&W Engineers over many years has resulted in the production of equipment for all methods of firing: chain-grate stokers for small and intermediate sizes of boilers, coal pulverizers and burners for both small and large units, oil burners of both steam-atomizing and mechanical-atomizing types, and combination burners wherewith high combustion efficiency is obtained with pulverized solid fuels, oil, or gas, either singly or in any combination.

B&W Type B Pulverizers for coal use the ball-bearing principle of pulverizing—the most efficient known—and are available in capacities ranging from ¼ ton to 50 tons per hour.

The Bailey Water-Cooled Furnace Construction, of either the Block or Stud-Tube type, or a combination of both, meets the requirements of high capacity, availability, and efficiency over a wide range of heat liberation with low maintenance. It is applicable to all fuels and methods of firing.

B&W Superheaters, Air Heaters, and Economizers efficiently utilize the heat of the combustion gases for their individual specific purposes, whether installed singly or in any combination. They are sturdily constructed and have long life in their particular services.

The Babcock & Wilcox Company is prepared to furnish boiler units that are complete and built to the high standards for which the B&W name has become so well known, and containing the most advanced features of designs and construction—built under one individual responsibility covering each unit.

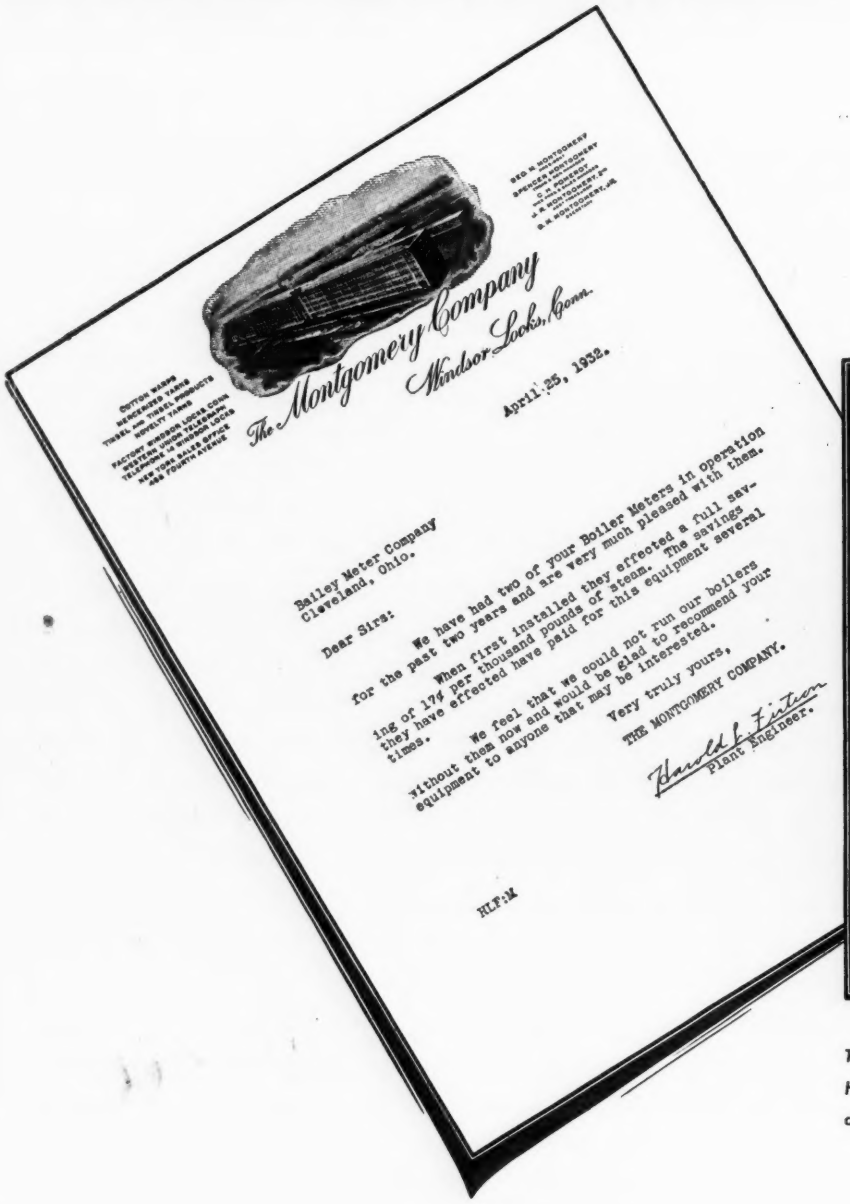
The Babcock & Wilcox Company, 85 Liberty St., New York, N.Y.

BABCOCK & WILCOX

G-35-T

PAYING DIVIDENDS—

at the Rate of 17 CENTS Per Thousand Pounds of Steam



The Montgomery Company
Windsor Locks, Conn.

April 25, 1932.

Bailey Meter Company
Cleveland, Ohio.

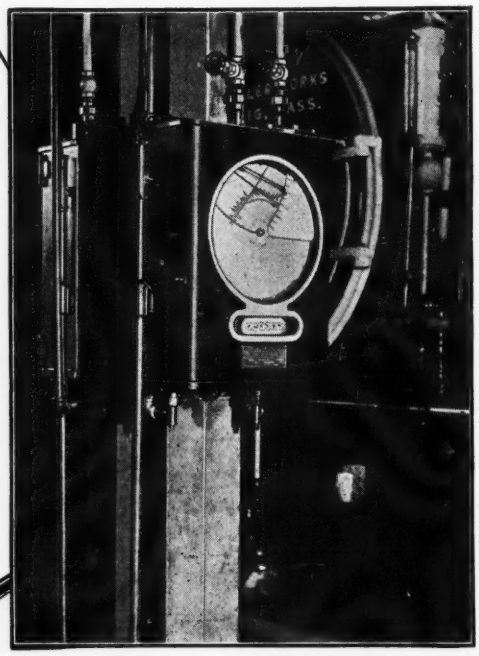
Dear Sirs:

We have had two of your Boiler Meters in operation for the past two years and are very much pleased with them. When first installed they effected a full saving of 17¢ per thousand pounds of steam. The savings they have effected have paid for this equipment several times.

We feel that we could not run our boilers without them now and would be glad to recommend your equipment to anyone that may be interested.

Very truly yours,
THE MONTGOMERY COMPANY.
Harold L. Fitton
Plant Engineer.

HLF:M



These Bailey Boiler Meters installed on two 150 hp. H. R. T. boilers at the Montgomery Company pay regular dividends at the rate of 17c per thousand pounds of steam.

STEAM COSTS have been decreased $.17 per thousand pounds at the Montgomery Company, Windsor Locks, Conn., by operating two 150 hp. boilers under guidance of Bailey Boiler Meters. This substantial dividend, which amounts to from $68.00 to $153.00 per week, has paid for the Bailey Boiler Meters many times since their installation approximately two years ago. Such money saving performance is typical of the experiences encountered by numerous small industrial plants utilizing Bailey Boiler Meters. Whether the fuel be coal, oil, or gas, these meters produce excellent results on boilers of 100 hp. or larger. If your boilers are being operated without the aid of combustion guides, you will find that an investment in Bailey Boiler Meters pays handsome dividends.

Request bulletin No. 44 for complete information.

BAILEY METERS

Boiler Meters
Combustion Control
Multi-Pointer Gages
Feed Water Control
Fluid Meters
Recorders

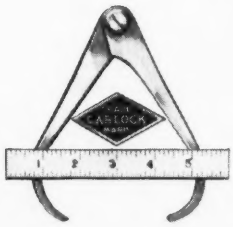
D-10A

BAILEY METER CO.

1036 IVANHOE ROAD CLEVELAND, OHIO.

Bailey Meter Company Limited, Montreal, Canada

GARLOCK *Lubricating Paste*



MAKES PACKINGS LAST LONGER!

TO replace the hand-mixed compounds frequently used and to provide packing users with an effective, economical packing lubricant, Garlock Lubricating Pastes were developed.

These pastes are scientifically compounded from the highest grade materials. They have extraordinary lubricating value. When applied to packings at regular intervals friction is reduced, maximum efficiency obtained, and the life of packings in service prolonged.

COMPOUND NO. 3

Garlock Compound No. 3 is for use on rod or plunger packings working against gasoline, benzine, oils, ether, carbon tetrachloride, kerosene, diphenyl, and all vapors and chemicals of an oily nature.

COMPOUND NO. 2

Garlock Compound No. 2 is for use on rod or plunger packings working against steam, hot water, cold water and water solutions. Reduces friction to a minimum . . . resists heat and maintains proper viscosity . . . water and steam proof . . . prevents rust and corrosion . . . extends life of packing.

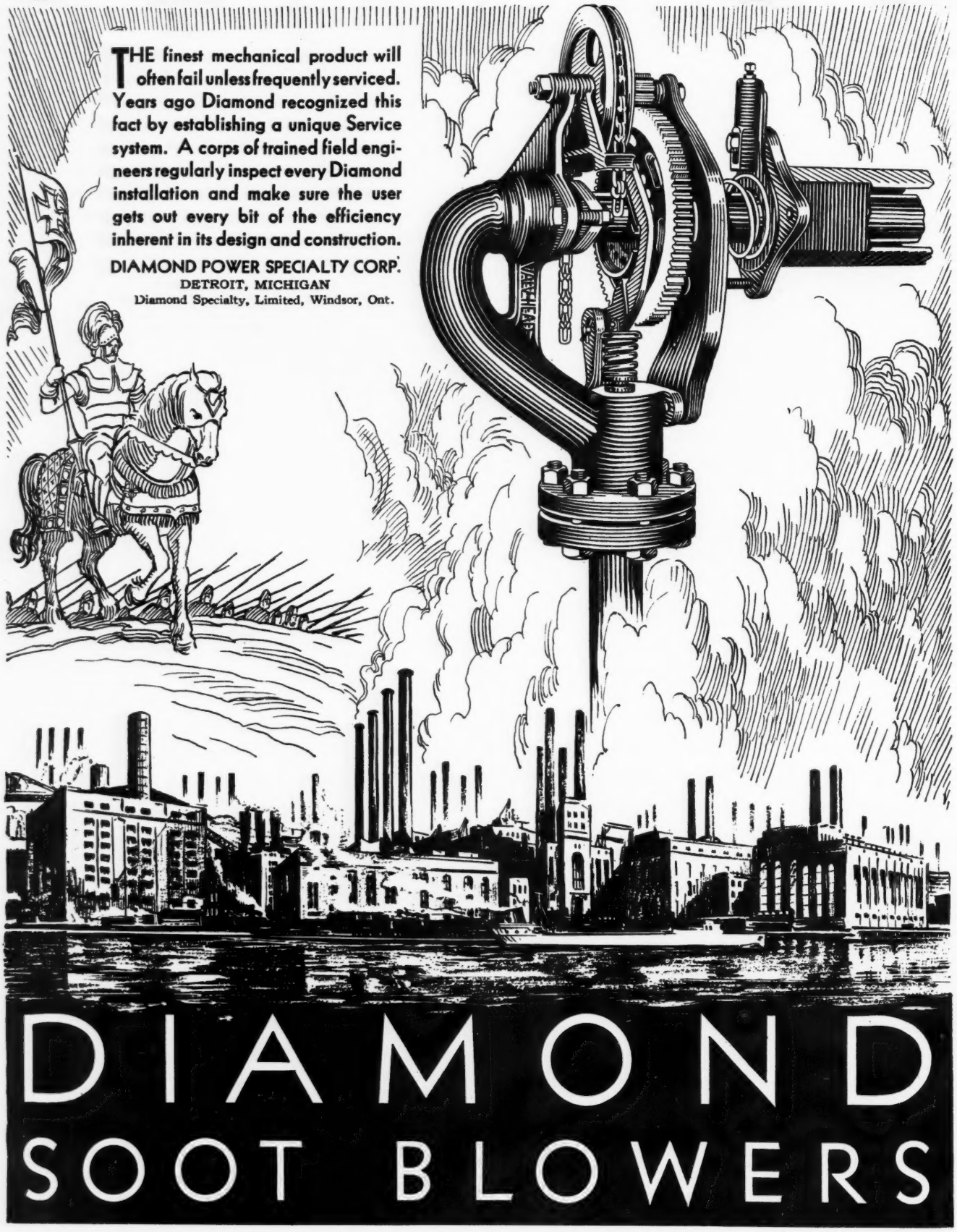
Specially compounded to Garlock formulas

Garlock Lubricating Pastes are supplied in 12 oz., 24 oz., and 5 lb. cans; also in bulk. Place a trial order now!

THE GARLOCK PACKING CO.
Palmyra, N. Y.

In Canada: The Garlock Packing Co. of Canada, Ltd., Montreal, Que.

SERVICE



THE finest mechanical product will often fail unless frequently serviced. Years ago Diamond recognized this fact by establishing a unique Service system. A corps of trained field engineers regularly inspect every Diamond installation and make sure the user gets out every bit of the efficiency inherent in its design and construction.

DIAMOND POWER SPECIALTY CORP.
DETROIT, MICHIGAN
Diamond Specialty, Limited, Windsor, Ont.

DIAMOND
SOOT BLOWERS

A MESSAGE
for Power Plant Executives

★

HEDGING AGAINST *the* DOLLAR

★

Thousands of conservatively managed industries are still well protected by liquid surpluses. And while the management watches the deflation of their surplus dollars, some consideration could well be given to plant rehabilitation, replacement of obsolete equipment, obtaining lower maintenance and higher efficiencies. As stabilization is effected, the profits on new equipment would tend to offset the depreciated surplus.

With fixed wages and hours and "code" pegged resale prices, the importance of higher plant efficiencies becomes the main factor of economy.

To those industrial plants or institutions interested in prospective economies of more modern stoker practice and the consequent savings at the coal pile, we offer the services of our national organization of trained power survey engineers, who will be glad to make a complete survey of your fuel problem without cost or obligation.

★ ★ ★

Repeat orders are splendid evidence of satisfied ownership. On your request we will send you a list of nationally known companies who have placed repeat orders for Firite Stokers during 1933. There is a complete story of Firite performance awaiting your request. We do our part.

Firite STOKERS

HOFFMAN COMBUSTION ENGINEERING CO.

DETROIT, MICHIGAN

Branches in Principal Cities

INSTALLING COPES
ON 1933's HIGHEST PRESSURE BOILER

A leading manufacturer (name on request) has selected the COPES Type SLH Regulator for a new Babcock & Wilcox Cross-Drum Boiler to operate at 750 pounds pressure. This is the highest operating pressure for which any commercial boiler was purchased in 1933 (as of November 10). The Type SLH is the latest design of the COPES Regulator in service on all the 1400-pound pressure boilers at Edgar Station . . . and on other outstanding high-pressure boilers throughout the world.. A COPES Type 3-SH-2 Valve will maintain a uniform differential pressure in the feed line.

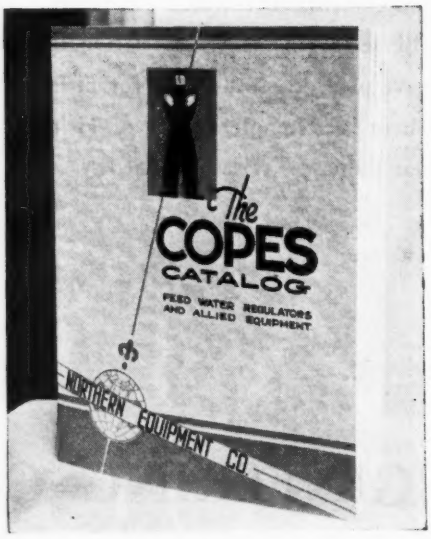
Why do leading consulting and operating engineers select COPES for important installations? For the same reasons that the great majority of all operating engineers prefer the fully-automatic COPES: Simplicity. Accuracy. Dependability. These things assure better results . . . longer life . . . lower costs.

The Type SLH Regulator is described in the new COPES Regulator Catalog.

COPES ALSO SELECTED IN 1933 FOR:

Cincinnati Rubber Co. . . . . 300 Pounds W.S.P.
The Springs Cotton Mills. . 300 Pounds W.S.P.
Tubize Chatillon Mills . . . 300 Pounds W.S.P.
Titanium Pigment Co. . . . . 320 Pounds W.S.P.
Container Corp. of America 350 Pounds W.S.P.
Wyandotte Pumping Sta. . 400 Pounds W.S.P.
Independent Oil & Gas Co. 440 Pounds W.S.P.
Cleveland Worsted Mills. . 450 Pounds W.S.P.
General Aniline Co. . . . . 450 Pounds W.S.P.
Jeddo-Highland Coal Co. . . 450 Pounds W.S.P.
Philadelphia Navy Yard. . . 450 Pounds W.S.P.
Southern Alkali Corp. . . . . 465 Pounds W.S.P.
Fox Paper Co. . . . . 650 Pounds W.S.P.
Detroit Edison Co. . . . . 682 Pounds W.S.P.
and more than 200 other plants.

CUT YOUR COSTS WITH COPES



SEND FOR NEW CATALOG WHICH TELLS HOW

Fuel prices are rising. A good way to cut fuel consumption is to install COPES. Others are doing it. Typical results are shown in this unusual new Catalog. Photographs, diagrams and charts illustrate methods and equipment. Send for a copy.

NORTHERN EQUIPMENT COMPANY
1221 Grove Drive, Erie, Pa.

Branch Plants in Canada, England, France, Germany, Austria and Italy.
Representatives Everywhere.

NRA
WE DO OUR PART

COPES
SYSTEM OF BOILER FEED CONTROL

THERE are dozens more, but no more are needed. In any of these famous and common examples the component parts are "useless each without the other", as the poet said.

It's the same with oils and greases. A good Crude can't become a good lubricant with poor refining. Neither can good Refining make a good oil from a poor Crude. And good Crude plus good Refining cannot bring to you maximum economy, long machine life, and fullest satisfaction, without Application to insure proper use.

You need all three to make a satisfactory lubricant, and Pure Oil offers that rare combination. Why not have all three? Especially since the Pure Oil price compares favorably with others boasting only one or two of the three essentials?

Give 20 minutes to a Pure Oil Engineer. He can make those minutes as productive as almost any others you've spent in business.

PURE OIL'S 3-POINT SERVICE — *YOU NEED IT*

(1) The right kind of CRUDE is important. Some types are better adapted to certain uses than others. Pure Oil Crude comes from many fields in nine states, not from a single area producing only *one* kind of Crude that must be recommended and sold for *every* lubrication need.

(2) Good REFINING is also vital. No commercially practical Refining process can add missing properties to inferior crudes. But even the best Crude must be correctly Refined to prevent loss of inherent lubricating values. Pure Oil modern Refining methods preserve and *improve* the lubricating qualities of Pure Oil superior Crudes.

(3) Scientific APPLICATION is equally important. Good Crude and good Refining go for naught unless skilled engineering selects the best types of oil for the particular job in question. Pure Oil Engineers are not only lubrication experts, they have had extensive experience in practical plant operation problems.

The PURE OIL *Company*

PRODUCERS, REFINERS AND MARKETERS OF A COMPLETE LINE OF PETROLEUM PRODUCTS

REFINERIES:

Marcus Hook, Pa. Heath, O. Toledo, O.
Muskogee, Okla. Ardmore, Okla.
Mt. Pleasant, Mich.
Smith's Bluff, Texas Cabin Creek Jct., W. Va.

BRANCH OFFICES:

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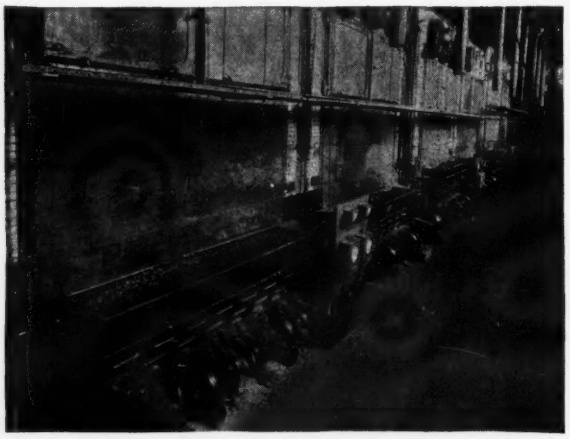
(A7361)

FEDERAL, STATE AND MUNICIPAL

WORK

Architects, Consulting Engineers, Officials, and Contractors, charged with responsibility for the selection of equipment for PUBLIC WORK, have approved DETROIT STOKERS. The record for satisfactory, continuous performance, with bituminous coal, available in various sections is acknowledged. Distinctive features of design and application, embodied in DETROIT STOKERS represent over thirty years experience in exclusive stoker manufacture. Thousands in operation. There is a DETROIT STOKER for every service.



United States Military Academy, West Point, New York

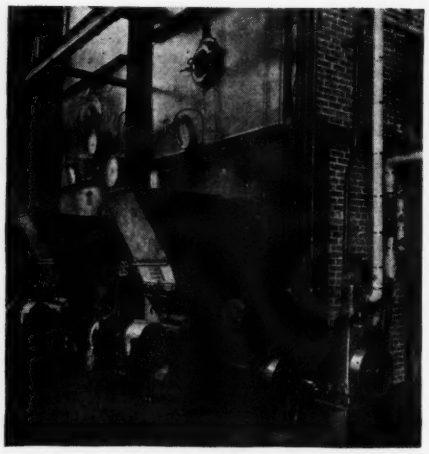
(partial list)

FEDERAL

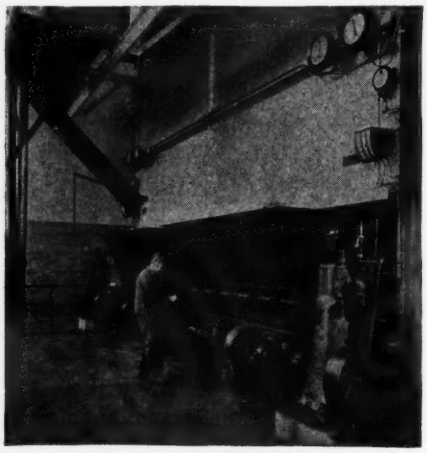
U. S. Veterans Bureau . Washington, D. C.
U. S. Veterans Hospital . . Bath, N. Y.
U. S. Veterans Hospital . Lexington, Ky.
U. S. Veterans Hospital . Johnson City, Tenn.
U. S. Veterans Hospital . Canandaigua, N.Y.
U. S. Veterans Hospital . Chillicothe, O.
U. S. Veterans Hospital . Columbia, S. C.
U. S. Veterans Hospital . Battle Creek, Mich.
U. S. Post Office . . . Brooklyn, N. Y.
U. S. Post Office, 3rd St. Sta., Cincinnati, O.
Federal Reserve Bank . . St. Louis, Mo.
Walter Reed Hospital . Washington, D. C.
St. Elizabeths Hospital . Washington, D. C.
U. S. Military Academy . West Point, N. Y.

STATE

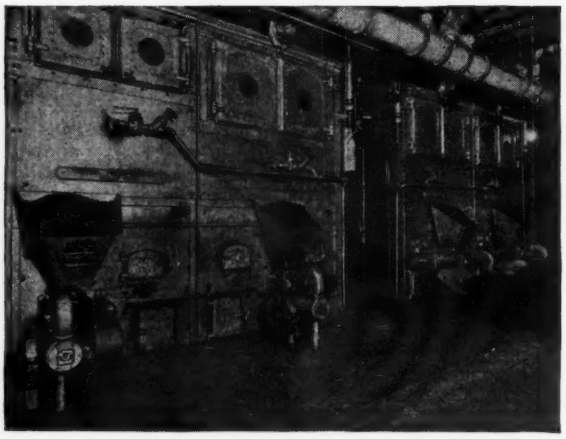
New York State Hospital, Raybrook, New York
Michigan State College, Lansing, Michigan
Kentucky Penitentiary, Eddyville, Kentucky
State Hospitals . . Petersburg & Marion, Va.
Georgia School of Technology, Atlanta, Ga.
State Teachers College . Kirksville, Missouri
Indiana Boys School . Plainfield, Indiana
University of Virginia, Charlottesville, Virginia
State Normal College . Richmond, Kentucky
State Normal Coll., Bowling Green, Kentucky
State Capitol . . . Richmond, Virginia
State Hos. for Insane . Waterbury, Vermont
State Hospital . Harding, Massachusetts
State Farm . . . Niantic, Connecticut
State Hospital . . Rochester, Minnesota
Indiana School for The Blind . . . Indianapolis, Indiana
State Colony for Epileptics . . . . Cambridge, Minnesota
State Institution for Feeble Minded . . Columbus, Ohio
State Teachers College . E. Radford, Virginia
State Teachers College . Farmville, Virginia
State Hospital . . Traverse City, Michigan
State Hospital . . . . Pontiac, Michigan
Colo. General Hospital . Denver, Colorado



Napoleon, Ohio—Municipal Water Works



State Hospital—Pontiac, Michigan



Columbus City Hall, Columbus, Ohio

MUNICIPAL

Cincinnati City Hall . Cincinnati, O.
District Jail . . Washington, D. C.
St. Louis Public Library . St. Louis, Mo.
Herman Kiefer Hospital . Detroit, Mich.
New York Penitentiary, Rikers Is., N.Y.
Municipal Plant . Penn Yan, N. Y.
Jackson Water Works . Jackson, Mich.
General Hospital, Minneapolis, Minn.
Municipal Plant . . Montpelier, O.
Oliver Water Works, South Bend, Ind.
Municipal Plant . Nicholasville, Ky.
City Hospital . . Springfield, O.
Water Works . Benton Harbor, Mich.
Lighting Plant . . Milford, Del.
General Hospital . Ashtabula, O.
Light & Water Works . Dover, Del.
Buffalo City Hospital, Buffalo, N. Y.
City Work House, Minneapolis, Minn.
War Memorial Aud. . Louisville, Ky.
Emergency Hosp., Washington, D. C.
General Hospital . Jamestown, N. Y.

WRITE FOR BULLETIN 830

DETROIT STOKER COMPANY

DETROIT, Mich. • *General Motors Bldg.* • Works at MONROE, Mich.

District Offices In Principal Cities

BUILT IN CANADA FOR CANADIAN TRADE

DETROIT STOKERS

RAPID
TROUBLE FREE
INSTALLATION
PROMOTED BY
THE
WORKABILITY *of* .....

J&L
HOT ROLLED SEAMLESS STEEL BOILER TUBES

J&L PIPE

J&L STEEL PIPE—WELDED AND SEAMLESS—SERVES PIPING NEEDS THROUGHOUT INDUSTRY.

The J & L hot rolled seamless process—an advanced step in the manufacture of boiler tubes—improves the quality of the product in every stage of manufacturing. It imparts exceptional ductility and makes J & L Boiler Tubes especially adapted to rolling in and beading. Their superior appearance is noted by all who see them. J & L Hot Rolled Seamless Steel Boiler Tubes comply with A.S.M.E. Boiler Code, A.S.T.M. Specifications and U. S. Steamboat Inspection Service Rules and Regulations. They are furnished in a full range of standard sizes, from 1″ O.D. to 6″ O.D. inclusive. Inquiries invited.

J&L STEEL

JONES & LAUGHLIN STEEL CORPORATION
AMERICAN IRON AND STEEL WORKS
JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

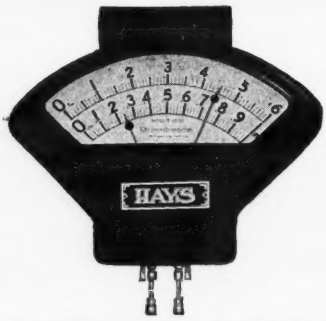
Sales Offices: Atlanta Boston Buffalo Chicago Cincinnati Cleveland Dallas Denver Detroit Erie Los Angeles Memphis Milwaukee Minneapolis New Orleans New York Philadelphia Pittsburgh St. Louis San Francisco
Warehouses: CHICAGO CINCINNATI DETROIT MEMPHIS NEW ORLEANS PITTSBURGH
Canadian Representatives: JONES & LAUGHLIN STEEL PRODUCTS COMPANY, Pittsburgh, Pa., U. S. A., and Toronto, Ont., Canada

Facts prove that COMBUSTION INSTRUMENTS cut fuel losses—

—why be satisfied with anything less than

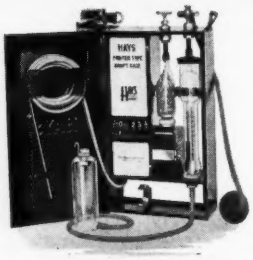
HAYS' ACCURACY?

Hays Dry Type Pointer Gages tell the fireman how to regulate his damper, the stoker speed or burner adjustment, when to change fuel bed thickness, and many other things the eye cannot detect unaided and about which it is expensive to guess. A "Type V" triple-pointer gage is shown above.

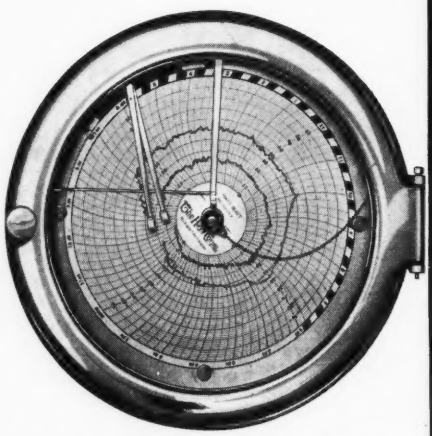


Hays Pointer Gages are available in standard sizes to measure any range of pressure from 1–10 to 100 inches of water. They can be used to indicate draft, pressure, and differential draft or pressure. Temperature and high pressure indicators can also be incorporated with wall or flush mounting. One or two pointers can be used on the "Type F" gage, above.

The ingenious water-operated Hays, Orsat type, CO_2 Recorder provides features of accuracy and dependability found with no other motivating force. Various combinations of Recorders and Recorder-Indicators for CO_2, furnace draft, and flue gas temperature and several styles of mountings for walls and for panels are available. Oxygen Recorders and combination recorders for CO_2 and Oxygen have recently been introduced.



A complete range of portable gas analyzers are offered in the Hays' line. Above is the new TS-3001 Test Set which combines the world's fastest gas analyzer (Orsat) with a Pointer Type Draft Gage to form an amazingly compact and inexpensive unit. For "trouble-shooting" and doing general "detective work" in the boiler room, a Hays Portable Combustion Test Set is ideal.



All engineers will appreciate the accuracy and dependability of Hays Recorders for making a continuous chart of draft and pressure conditions. They incorporate the same sensitive, powerful, slack leather diaphragm units that have won fame for Hays Pointer gages. Recorders for steam temperatures and pressures are also offered in cases fitted with lugs for wall mounting or flanges for flush mounting on instrument panels.

Sturdy, handsome Hays Instrument Panels offer the modern way to centralize the control instruments which write the performance records of men, fuel and equipment. Built to your own specifications.

HAYS Instruments and The Hays Organization have long been associated with the economical burning of fuel—with *combustion efficiency*. For many years "HAYS" has stood for lower fuel bills as the result of following simple, sound, scientific methods. Hays Instruments are built, calibrated, and tested by expert instrument makers whose interest and pride is in the high quality of work produced. Representatives are located in all important cities.

Descriptive literature on instruments for every purpose available on request.

The Hays Corporation
MICHIGAN CITY, IND.

SeezO$_2$ is the speedy new oxygen absorber. Absorbs 49 times own volume. Breaks abruptly. Changes color when exhausted. Is not affected by light. Good for 400 flue gas samples. Try it!

33.8% $AVING

in lubrication costs with SINCLAIR RUBILENE

HERE is convincing proof of the savings possible with the use of Sinclair Rubilene in Diesel engine operation.

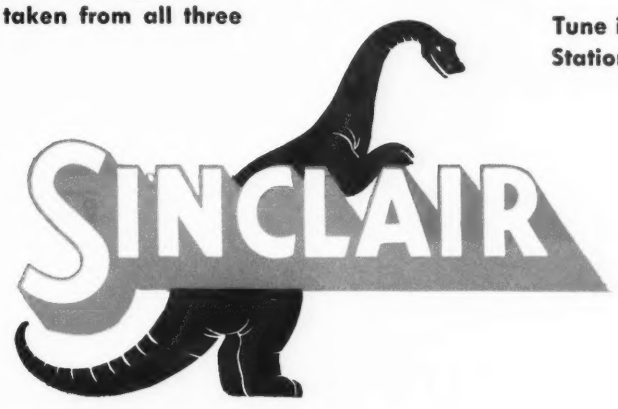
In Central Pennsylvania, a manufacturer operated a Fairbanks-Morse engine using a competitive oil at a daily cost for lubrication of 68¢.

Then he switched to Rubilene, paying 10¢ more per gallon for the Sinclair brand. But in actual use, Rubilene *actually reduced* this manufacturer's oil expense by 23¢ per day, effecting a saving in lubrication costs of 33.8%.

Why do Sinclair oils make savings like these possible? (In some instances, savings run as high as 47.6%.) Because Sinclair almost alone among refiners has access to the oldest crudes taken from all three main producing areas—the Pennsylvania, Mid-Continent and Gulf Coast fields. With this wide choice of crudes which are made into 200 finished grades of industrial lubricants, and their knowledge of lubrication requirements, Sinclair engineers recommend the most efficient and most economical oil for a specific purpose.

Sinclair engineering service is at your command. Call or write our nearest branch office or any local Sinclair Agency. Sinclair Refining Company (Inc.), New York, Atlanta, Chicago, Houston, Fort Worth, Kansas City. Sinclair Refining Company of California, Los Angeles.

Tune in Monday Evenings 40 NBC Stations — SINCLAIR MINSTRELS

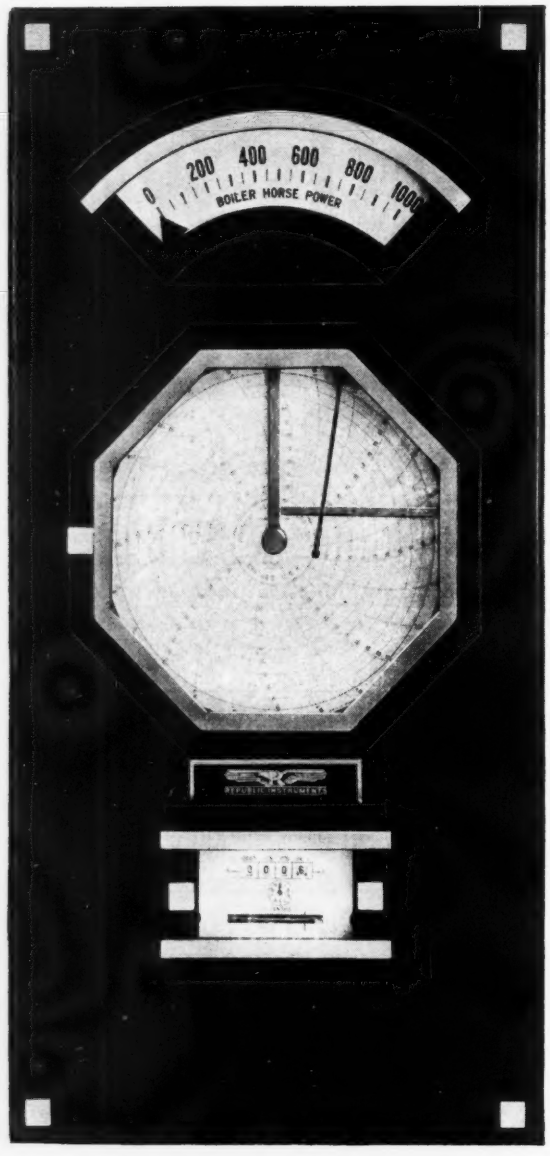


NRA MEMBER U.S. WE DO OUR PART

INDUSTRIAL OILS **FUEL OILS** **GREASES**

NEWS

REPUBLIC ANNOUNCES AN IMPORTANT DEVELOPMENT IN FLOW METER DESIGN



"CARTRIDGE SEALED ELEMENTS"

The *utter simplicity* of the new Republic Flow Meter is outstanding. You are conscious of a certain trimness characteristic of a product well engineered and well designed. Each actuating unit has been built into a metal cartridge protecting it against dirt, moisture and abuse. Each *cartridge sealed element* is a separate, independent and interchangeable unit. It can be readily removed from the instrument without disturbing or exposing any other mechanism. This new conception of instrument design is destined to play an important part in future flow meter specifications because of its inherent advantages.

Vigorously distinctive in appearance and design, the new Republic Flow Meter retains the same basic principle of operation—a principle so sound that it remains practically unchanged after twenty-three years of service. The ability of a Republic Flow Meter to render accurate, uninterrupted service has been so conclusively demonstrated over a long period of time, that it is no longer seriously questioned.

Why not acquaint yourself with the features of this outstanding development in flow meter design? WRITE FOR BULLETIN No. 700.

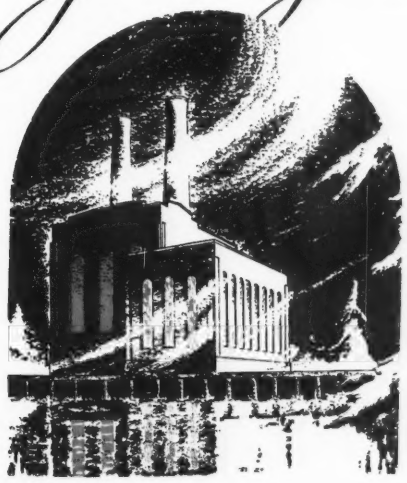
REPUBLIC
INSTRUMENTS

REPUBLIC FLOW METERS CO.

2222 DIVERSEY PARKWAY, CHICAGO, ILLINOIS

To the men who operate Boiler Plants

Greetings



We wish you a Merry Christmas and a Happy, trouble-free New Year!

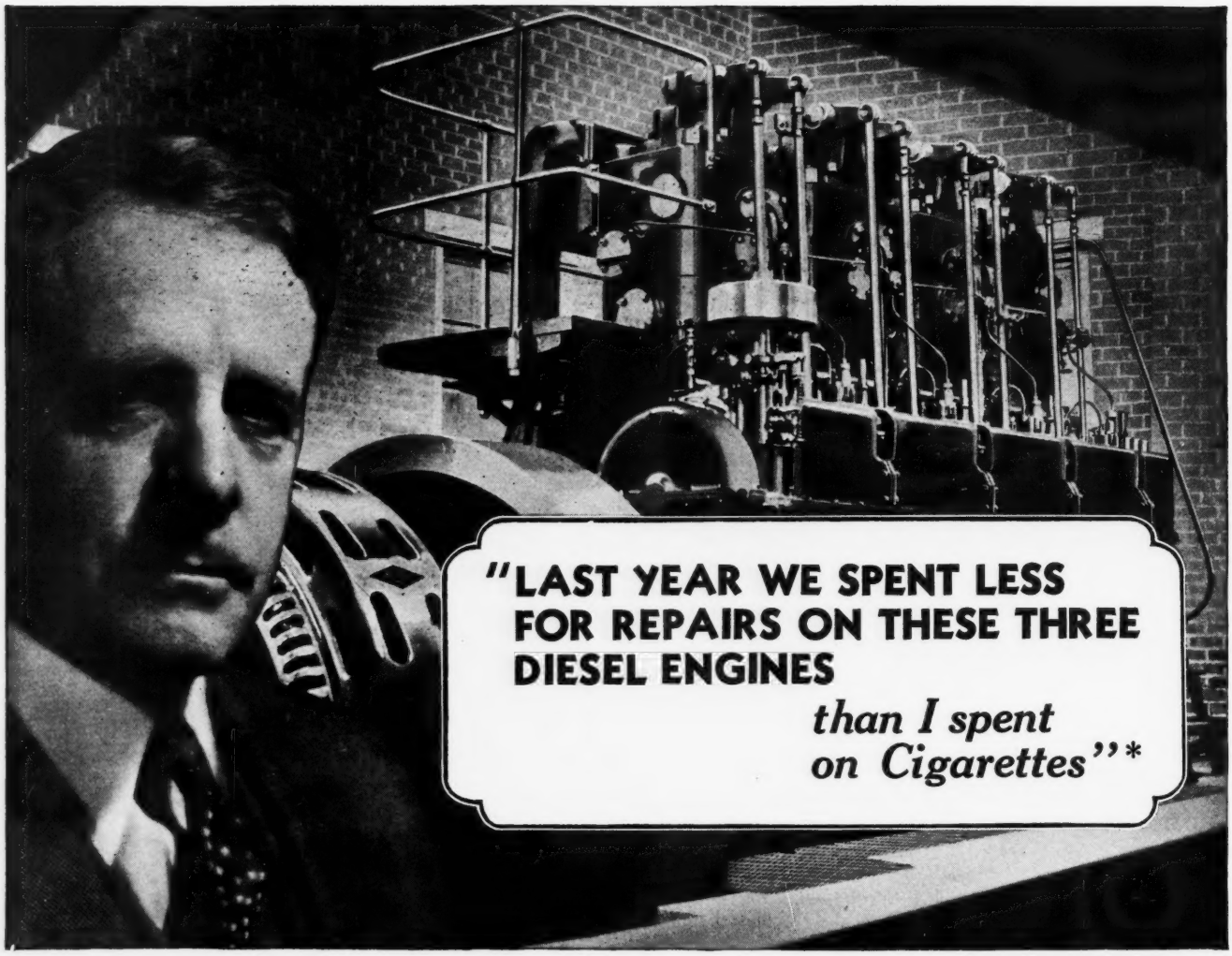
We owe our friends throughout the power plant field of America a sincere expression of gratitude for the support they have given us during the trying years immediately behind us. We take this means of voicing our appreciation.

Our intimate knowledge of your problems enables us to recognize the courage you have displayed in your fight to maintain efficient, safe operation in the face of indiscriminately tightened purse strings.

Let us hope that the New Year and the New Deal will bring with them a new conception of the wisdom of **spending to save.**

HAGAN CORPORATION **HALL LABORATORIES, INC.** **THE BUROMIN COMPANY**

PITTSBURGH, PA.



When you consider Diesel engines

CHECK THESE POINTS

- √ 1. Low Fuel Consumption
- √ 2. Low Lubricating Oil Consumption
- √ 3. Quietness—absence of vibration
- √ 4. Simplicity of Design
- √ 5. Rugged Construction
- √ 6. Generous Proportions of Vital Parts
- √ 7. The Finest Precision Workmanship throughout
- √ 8. Easy Accessibility for Quick Servicing

These are the factors that insure operating economy, low maintenance expense, reliability and long life in a Diesel Engine. Their presence in Da La Vergne Diesels makes them the smoothest and quietest running Diesel engines ever built."

"—and two of these De La Vergne engines are over 8 years old."

This is not just one isolated case. It is typical of De La Vergne Engine-equipped plants everywhere. The reason that maintenance is negligible with De La Vergne Diesels is the absence of failures of major engine parts.

For instance, records on Type VA and VB Engines show there has never been a crankshaft failure, no crankpin bolt failures, not a single cylinder head failure where correctly designed cooling systems have been provided, no camshaft drive failures and bearing replacement is so exceptional that it is practically unknown.

Maintenance economy has been *built into* every one of these engines.

Correct design, generous proportions and precision workmanship of the highest order have removed the trouble centers in Diesel construction.

For low cost power from now on, select a smooth, quiet, vibrationless De La Vergne.

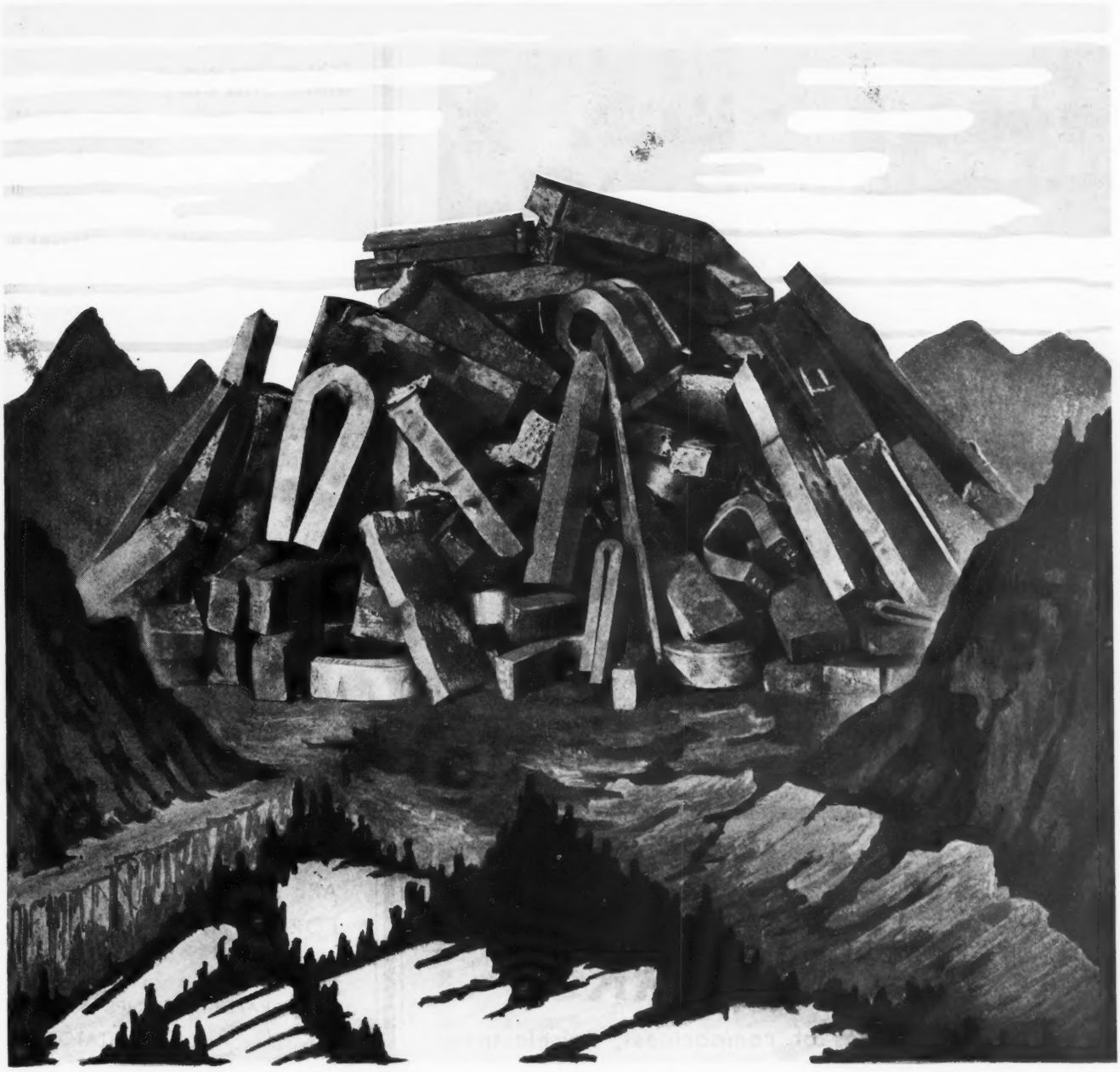
DE LA VERGNE ENGINE CO.
PHILADELPHIA, PA.

SALES AGENT FOR BALDWIN-SOUTHWARK CORP.
DIESEL DIVISION

Pacific Coast Representative: The Pelton Water Wheel Co., San Francisco

DE LA VERGNE DIESEL ENGINES

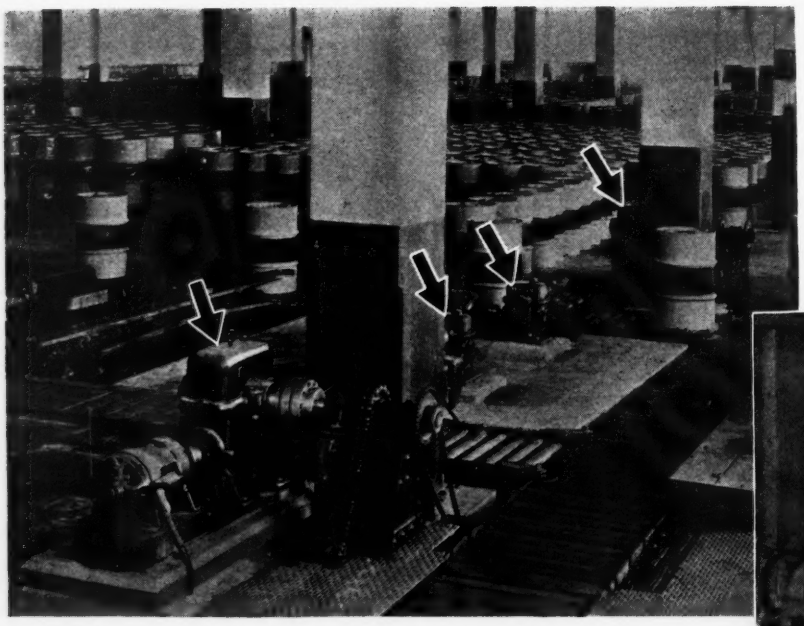
* Name of installation on request.



A Mountainous Test of Welding Skill

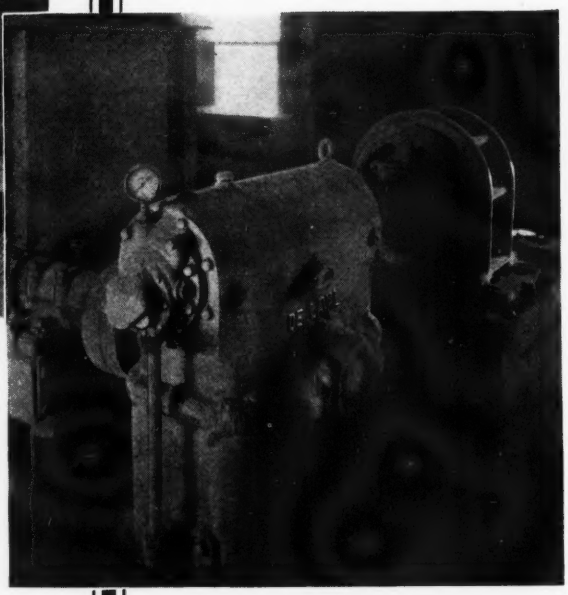
The honor of a place on the "Approved List of Fusion Welders of Pressure Piping" of the Hartford Steam Boiler Inspection and Insurance Co. is won only by passing their "mountainous" test, in which numerous welds must scale lofty peaks in the Nick Break, Free Bend, Back Bend and Reduced Section Tests. These peaks of welding perfection are higher and more exacting than in any other existing pipe welding code, and the failure of one weld to reach the required summit disqualifies the welder . . . We are justly proud of our place and grade on this "Approved List", for it means we have satisfied "Hartford Steam Boiler", that we are competent to fabricate fusion welded piping up to 1¼" wall thickness, by either the electric arc or oxy-acetylene process, in a manner that will be acceptable to them for insurance, whether the work be done in our shop or in the field . . . This "mountainous" test of "Hartford Steam Boiler" reveals the fallacy in the popular opinion that any good mechanic, with good equipment, can make a perfect weld anywhere. Even we, though qualified to produce "acceptable" welding under any condition, find it more economical and satisfactory to make as many welds as possible in our own shops, where we have the benefits of our modern adequate facilities . . . The Benjamin F. Shaw Co., Wilmington, Del.

SHAWCO



Roller conveyors in an oil refinery, driven through De Laval worm gears.

Bucket elevator in cement mill, driven through a De Laval worm gear.



For Driving Conveyors

DE LAVAL WORM GEARS

give the advantages of compactness, noiselessness and continuous operation.

They enable slow and moderate speed machines to be driven by inexpensive but efficient standard speed and high speed motors and turbines.

The few simple and rugged moving parts are completely enclosed and the drive is dust, grit and moisture-proof.

There is no danger to attendants, no interference with lighting, no stirring up of dust and no throwing of oil.

Single reductions give ratios of from 4 to 1 to 100 to 1, while double reductions give up to 8000 to 1.

DE LAVAL STEAM TURBINE COMPANY

Trenton, New Jersey

1033

DE LAVAL WORM GEARS ARE ALSO WIDELY USED FOR DRIVING • • • •

FEEDERS FURNACES
PAPER MACHINES
SCREENS AGITATORS
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and innumerable other industrial appliances.

A layout for your drive will be suggested without obligation on your part if you will tell us the nature of the driven machine, the driving and driven speeds, and the horsepower.

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WATER POWER
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STEAM SERVICES
ELECTRICITY & ELEVATORS
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POWER

Volume 77 Number 13

F. R. Low, Editor Emeritus; Philip W. Swain, Managing Editor; F. A. Annett; R. B. Purdy; E. J. Tangerman. Norman O. Wynkoop, Publishing Director

Mid-December, 1933

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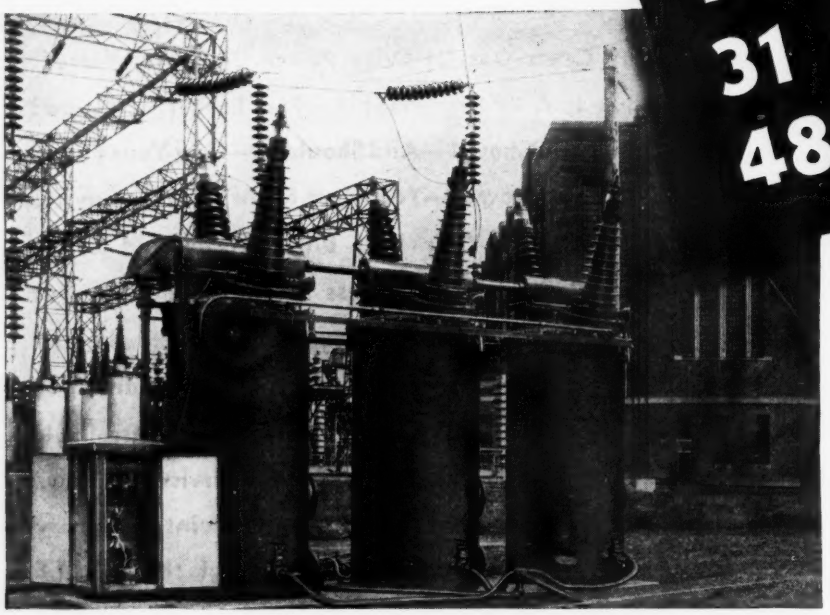
Another Company Modernizes Breakers with OIL BLAST —94 in 3 years—



Type FHKO-139 breaker modernized with oil blast

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Performance Counts. This is again evidenced by the fact that one of the large power companies has modernized an increasing number of breakers since 1931. During the last three years, 94 "FHK" outdoor-type G-E breakers, of various voltages, have been modernized and improved by the addition of oil blast.

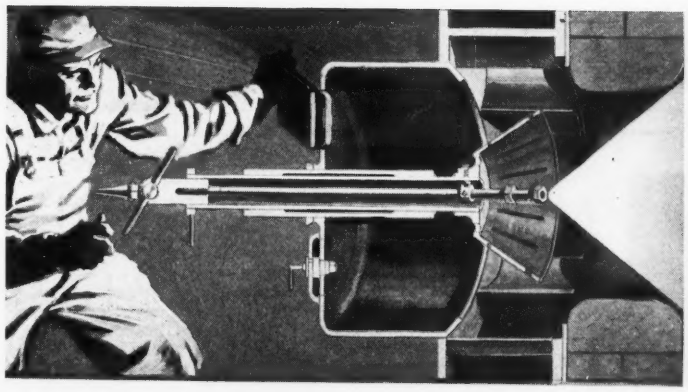
The engineers of that company have found that oil blast assures better performance and higher speed of circuit interruption. Each year the success of these modernized breakers added further evidence of the effectiveness of oil blast.

You, too, can modernize your G-E breakers —quickly, easily, and economically. The addition of oil blast will result in greater interrupting ability; decreased maintenance; greater security; better service; and the rapid clearing of faults, which is one of the important factors in stabilizing a system.

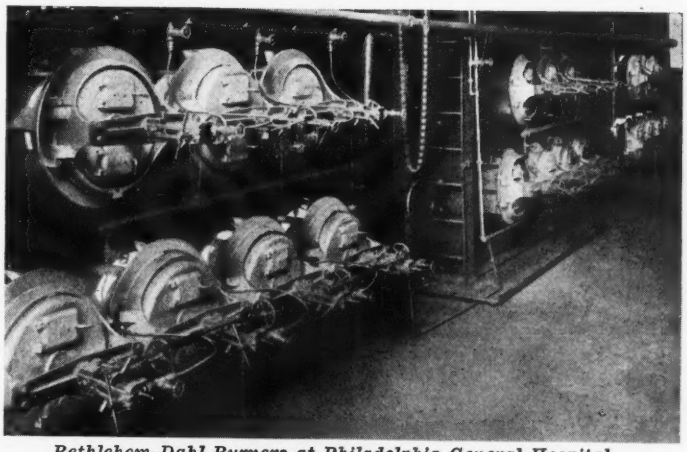
Send for detailed information which will explain how you can modernize the G-E breakers on your system. General Electric, Schenectady, N. Y.

470-42

GENERAL ELECTRIC



An INVESTMENT THAT QUICKLY PAYS FOR ITSELF



Bethlehem-Dahl Burners at Philadelphia General Hospital, Philadelphia, Pa.

Bethlehem-Dahl Burners at Spencer Kellogg Sons, Inc., Edgewater, N. J.

THE savings that result from adopting oil fuel, and using the Bethlehem-Dahl Mechanical Atomizing Oil Burning System, are so substantial that the installation quickly pays for itself. Not only does the economy of operation of the Bethlehem-Dahl System reduce fuel costs, but it eliminates ash disposal, and expensive upkeep of coal- and ash-handling equipment.

Equipping the boiler rooms of public buildings and institutions with Bethlehem-Dahl burners is an investment that is quickly self-liquidating, and means substantial savings of taxpayers' money.

Engineers in charge of Federal, state or municipal modernization projects will find the economies offered by the Bethlehem-Dahl Oil Burning System of decided interest. Without obligation, a Bethlehem engineer will gladly make a detailed study of the operating conditions of any boiler plant, and prepare a conservative estimate of the savings that could be realized by installing the Bethlehem-Dahl System. *Bethlehem Steel Company, Bethlehem, Pa.*

BETHLEHEM-DAHL mechanical-atomizing OIL BURNING SYSTEM

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. Gentlemen: Please send me descriptive literature on Bethlehem-Dahl Oil Burners.

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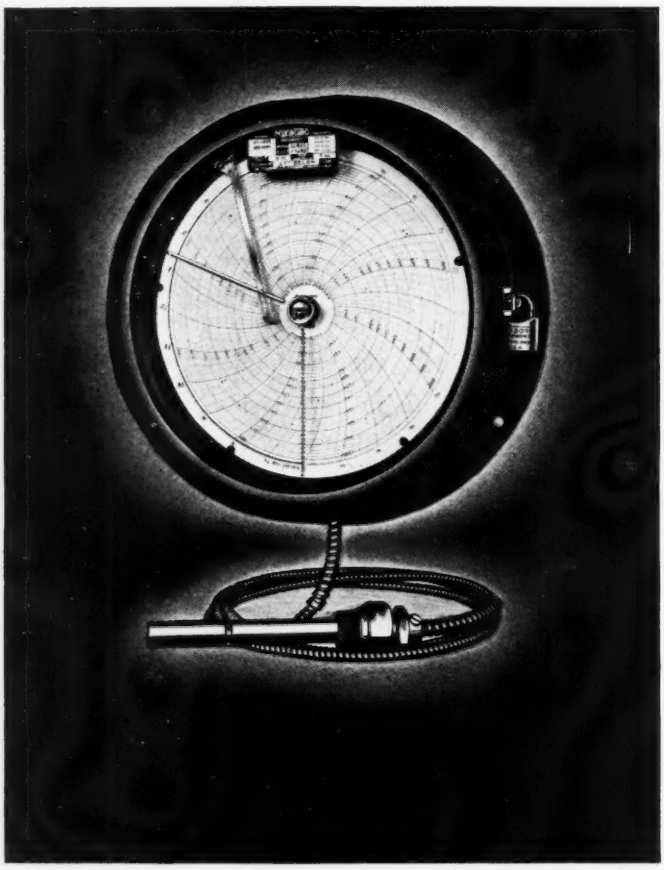
ADDRESS _____

COMPANY _____ POSITION _____

THE FIRST STEP



Foxboro Recording Thermometers are used extensively to measure Flue Gas Temperatures, since they furnish information that makes possible large savings in fuel.

FOXBORO
REG. U. S. PAT. OFF.
THE COMPASS OF INDUSTRY

Foxboro Instruments are "MODERN" in every sense of the word. Their attractive cases contain features that make the instrument easy and convenient to use. The use of the latest alloy metals has resulted in a lighter instrument that is more durable, responsive, and accurate than its so-called "rugged" predecessors. In addition, Foxboro Instruments have incorporated and made use of many of the new mechanical and electrical developments. You will find among Foxboro's Complete Line of Industrial Instruments, the correct answer to any instrument problem you may have.

MODERN INSTRUMENTS will show you WHERE to modernize and how to do it at *a minimum cost.*

- Your modernization program should be based on facts! Instruments furnish a daily check on your present equipment and show where the "weak spots" are. They give definite information that shows without question which pieces of equipment it will be economical to continue to use and which should be replaced.

- Foxboro Instruments will enable you to operate your present equipment more efficiently and economically. They are an investment in both present and future operation and will pay for themselves many times over. They are the logical first step in your modernization program because they cost little, yield a high return immediately and fit any future set-up.

• • • • •

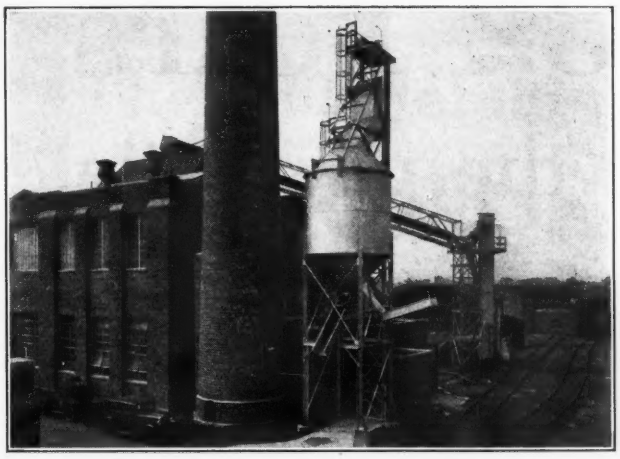
Instruments for so important a job as this cannot be bought "over the counter". Instrumentation requires engineering in addition to instruments. Modern instruments, correctly applied, give you the most for your instrument dollar.

Call in one of our Engineers to go over your modernization problem with you. He will see that you get the correct instruments for each application and his call will save you money. Write us freely for more details without obligation.

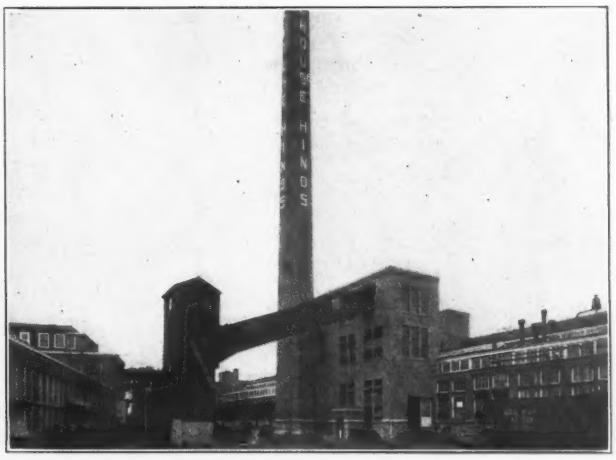
THE FOXBORO COMPANY, FOXBORO, MASS.

BRANCH OFFICES IN PRINCIPAL CITIES

• • • *Complete Industrial Instrumentation* • • •



BOILER HOUSE OF BAKELITE CORPORATION AT BOUND BROOK, N. J.



BOILER HOUSE OF MODERATE SIZE WITH AUXILIARY GROUND STORAGE

ROBINS

Considers no project too large or too small for careful planning of every detail.

The great public utility super power plant handling 1000 tons of coal per hour and the small industrial plant using less than 100 tons per day receive equal care and service.

ROBINS EQUIPMENT REDUCES COSTS

ROBINS

Forty years of experience in designing coal handling conveyors, skip hoists, elevators, etc., in power plants is available to you.

An engineer from our nearest office is at your service — Send for him.

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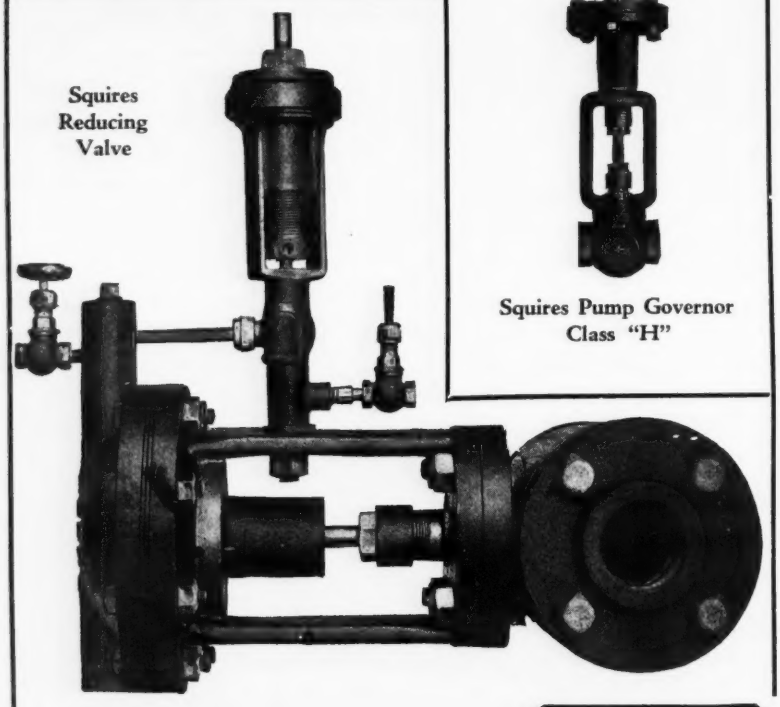
Genuine Squires Steam Trap

Squires Boiler Feed Water Regulator



Squires Reducing Valve

Squires Pump Governor Class "H"

32 Years

In the power field

From a handful of users, 32 years ago to thousands of today, Squires Steam Specialties are saving steam and adding to the operative efficiency of plants in every industry and in every state in America. Known for their sturdy construction and dependable operation, Squires Steam Traps, Feed Water Regulators, Pump Governors, Reducing Valves, etc., have a fine reputation for long life, freedom from repairs, and low maintenance costs.

Hundreds of plants today are in the process of modernization. Operating costs must be cut. Steam wastes must be stopped. Now is the time to replace antiquated and shop-worn equipment. Squires Steam Specialties will do their part. They are built right. They operate right. They do save in operating costs . . .

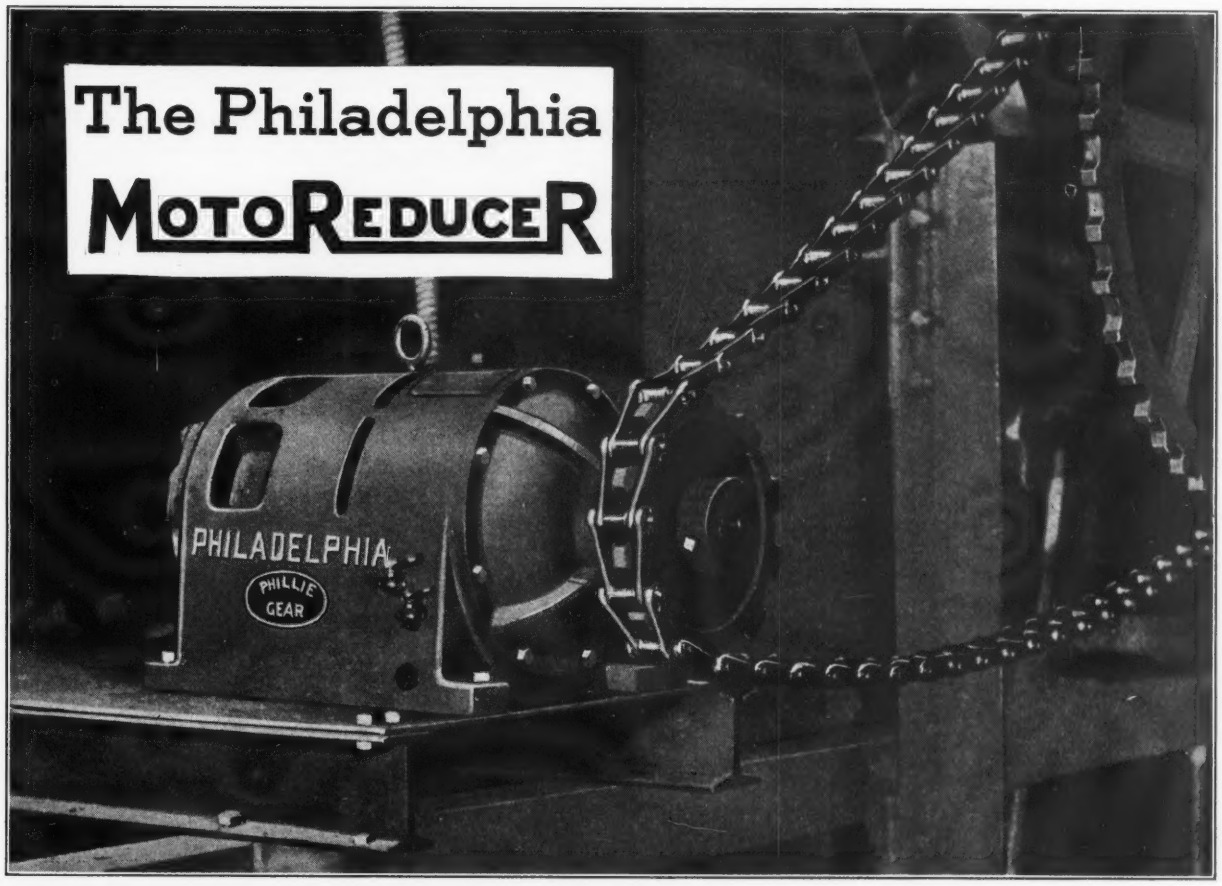
Look over our Catalog A-1 and become better acquainted with the Genuine Squires Steam Specialties and their adaptability to your plant. Have you this catalog? If not write for one today.

Insist on the Genuine Squires

Steam Specialties

THE C. E. SQUIRES COMPANY

E. 40TH ST. & KELLEY AVE., CLEVELAND



Hundreds of these Units are now solving Industry's Speed Reduction Problems *Economically and Efficiently*

The above installation is but another instance of the many severe or unusual services which the Philadelphia MotoReduceR has been called upon to meet. Notice the large overhung sprocket and heavy chain pull—one of the most severe tests to which a Speed Reducer can be put—yet the MotoReduceR operates silently, effectively and without trouble, day in and day out. We believe, that only the Philadelphia MotoReduceR will consistently meet such grueling service.

The MotoReduceR shown above is driving a Brick Press Elevator at the Refractories Plant of E. J. Lavino and Company, Plymouth Meeting, Pa., and is but one of a number of these Units installed by that Company.

What hundreds of MotoReduceRs are doing for others (in most every line of industry) they can do for you. Ask for the interesting MOTOREDUCER CATALOG and be convinced.

Just consider these great advantages:

The MotoReduceR is extremely compact (offering a considerable saving in space). All moving or revolving parts are "precision" balanced. Accurate alignment is permanently assured. No base plates or flexible couplings are required. Construction permits it to carry greater overhung load. In addition, the MotoReduceR is noiseless and vibrationless. Gives higher operating efficiency with only a minimum of operating expense and maintenance costs.

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PHILLIE GEAR

Industrial Gears and Speed Reducers
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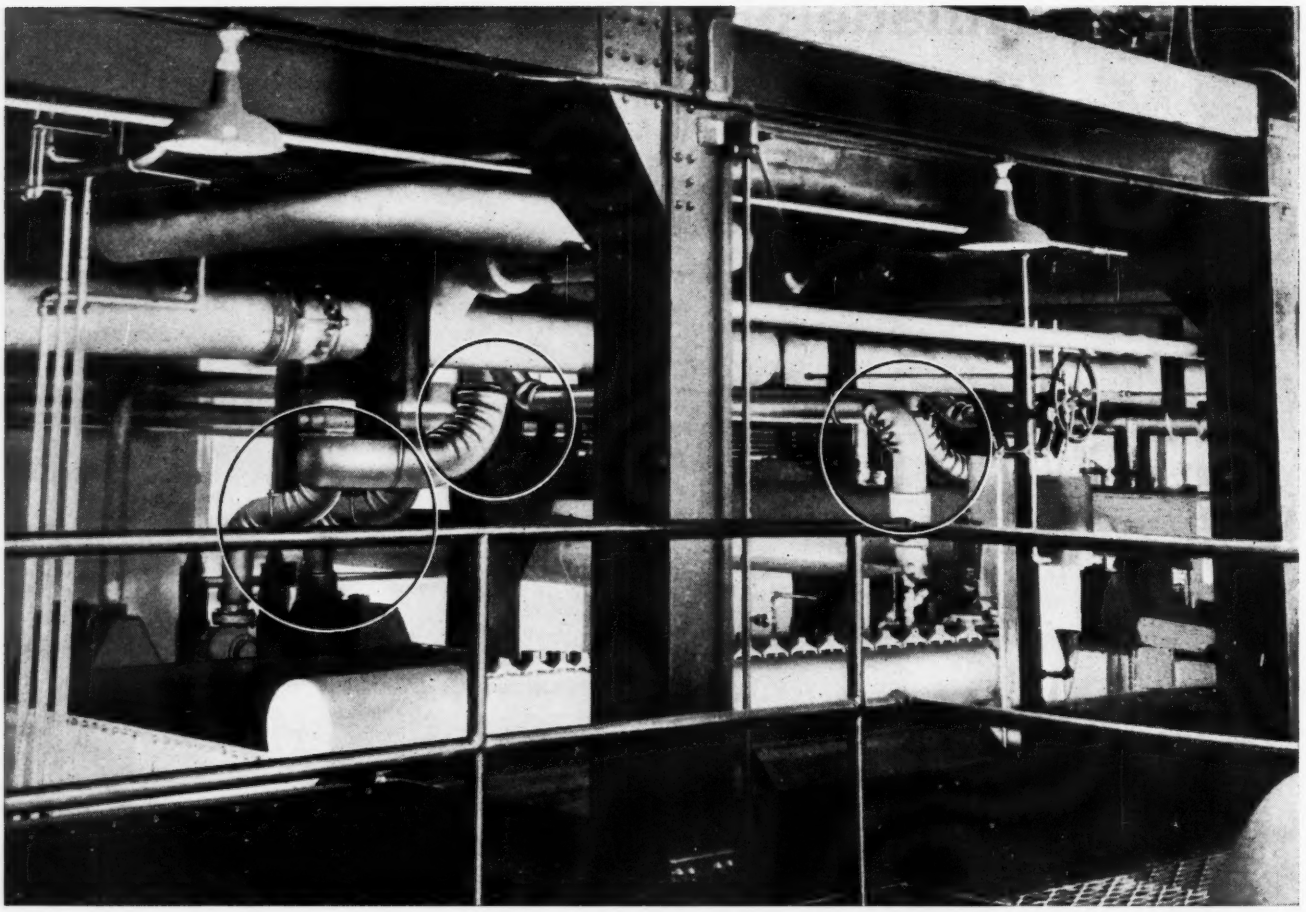
CREFLEX WELDING FITTINGS...



AT JULIUS FORSTMANN & COMPANY, INC.

A good illustration of what can be accomplished by using Creflex Welding Fittings to cope with limited space conditions is shown here in the boiler room piping of the Forstmann Woolen Company, Passaic, New Jersey.

Installation of Creflex Welding Fittings in the safety valve exhaust lines permitted closer nesting of piping and also eliminated over a dozen line welds, thereby reducing the number of welded joints to a minimum and effecting a considerable saving in cost.

Additional advantages are:—

Several Creflex Welding Fittings can be made in one continuous length of pipe in one or more planes.

Their longer tangents make it possible to locate all welds far from the zones of high stress, thus providing a higher factor of safety in the welds.

Creflex Welding Fittings are made from seamless tubing in full range of sizes and for all pressures.

Many engineers take advantage of these various features to secure a maximum of safety with a minimum of cost.

For further information and list prices, write for Bulletin W-101.

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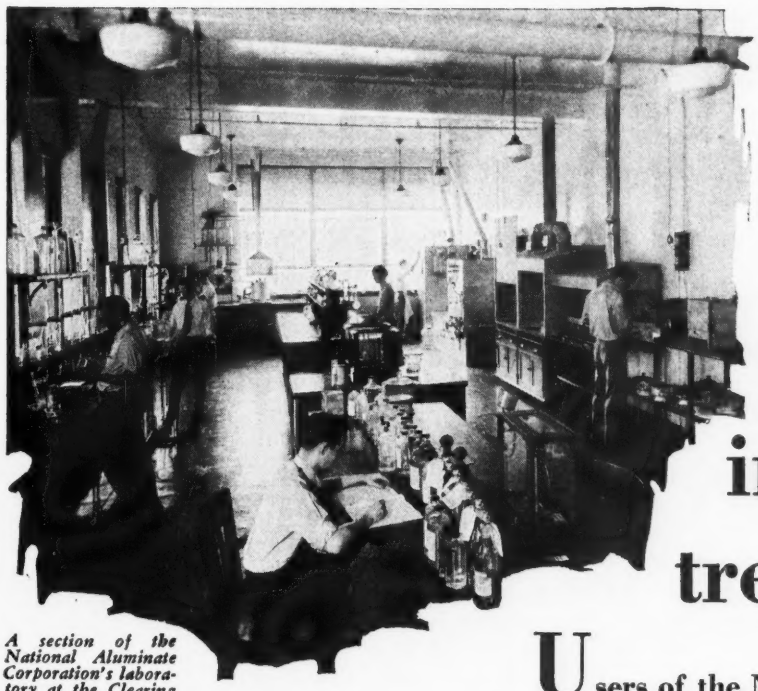

A section of the National Aluminate Corporation's laboratory at the Clearing (Chicago) Plant.

Make this YOUR Laboratory for Research in water treatment

Users of the Nalco System enjoy the full advantage of complete research facilities and a staff of leading specialists in water treatment.

We have spared no pains or expense in providing the best possible research work in water treatment problems. Without such work the Nalco standard of service would be impossible. But the problems we work on are your problems—either directly or indirectly. You get the benefit, just as though you owned the laboratory and paid the staff salaries.

Money saving recommendations in your plant today may be based on laboratory or plant investigations made by our research department months or years ago. If you have water trouble which is likely to be found in other plants similarly situated, but which cannot be adequately met out of our accumulated store of experience, we have unsurpassed facilities and professional ability which can be devoted to a solution of that problem. We have in many instances spent more money on such an investigation than we received from the customer for chemicals in many months.

If you are not familiar with the possibilities of "your" laboratory and "your" research staff, use the coupon below to ask for the first service — a FREE survey of your water conditions.

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National Aluminate Corporation, 6222 W. 66th Place, Chicago, Ill.

SODIUM ALUMINATE *(Nalco System)*

NATIONAL ALUMINATE CORPORATION
6222 W. 66th Place, Clearing Sta., Chicago, Ill.

☐ Send me your free booklet, "Standardized Feedwater Treatment."

☐ Have an engineer make a feedwater survey of my plant. This does not obligate me in any way.

☐ Give me names of nearby Nalco users or companies with plants similar to mine.

Name .....
Title .....
Company .....
Address .....
Type of Plant .....
City .....State P.12-Gray

Why Go to the

YOUR own factory may be a veritable gold mine! An important thing about this indoor prospecting is that it often strikes pay dirt which yields astonishing returns on the investment.

This gold may be hidden, but you have men in your organization qualified to find it — men who are eager and willing to learn about new materials, equipment, and methods. Encourage them to keep informed about these new developments and to continue to analyze the operations of your plant for opportunities to modernize the plant profitably. Then do your part . . . act on their sound recommendations so that you may increase profits by lowering costs.

There is a sales engineer in a G-E office near you who has had wide experience in working with industrial plants and with consulting engineers to effect economies and savings similar to those described on these pages. Study these examples; perhaps they will suggest a place in your plant where modernization will pay for itself and add to profits.

We have grouped in a 16-page booklet, "Modernization Pays" (illustrated below), many other interesting examples of profitable modernization. If you would like a copy, please fill in and mail the coupon on the opposite page. General Electric, Schenectady, N. Y.

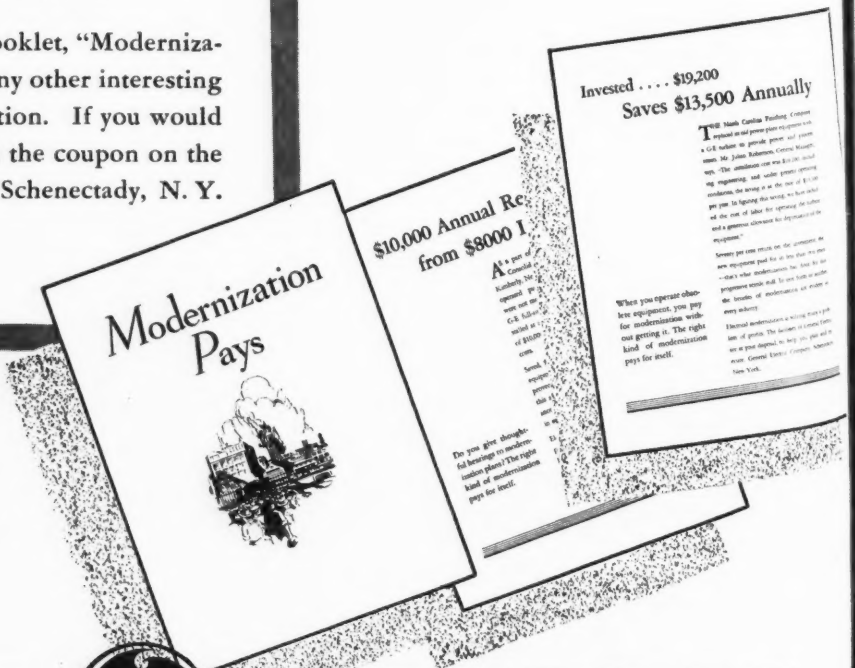
THIS MINE FINDS PAY DIRT ABOVE GROUND

The Powhatan Mining Company, Powhatan, Ohio, modernized an old ventilating-fan drive. The RIGHT G-E synchronous motor and control were installed at a cost of $3,258. Result: $4,500 saved annually—a 138-per-cent return on the investment.

TURBINE-GENERATOR SAVES $7,000 ANNUALLY

The University of Kansas generated its own steam and purchased electric power only in emergencies. Its costs were high.

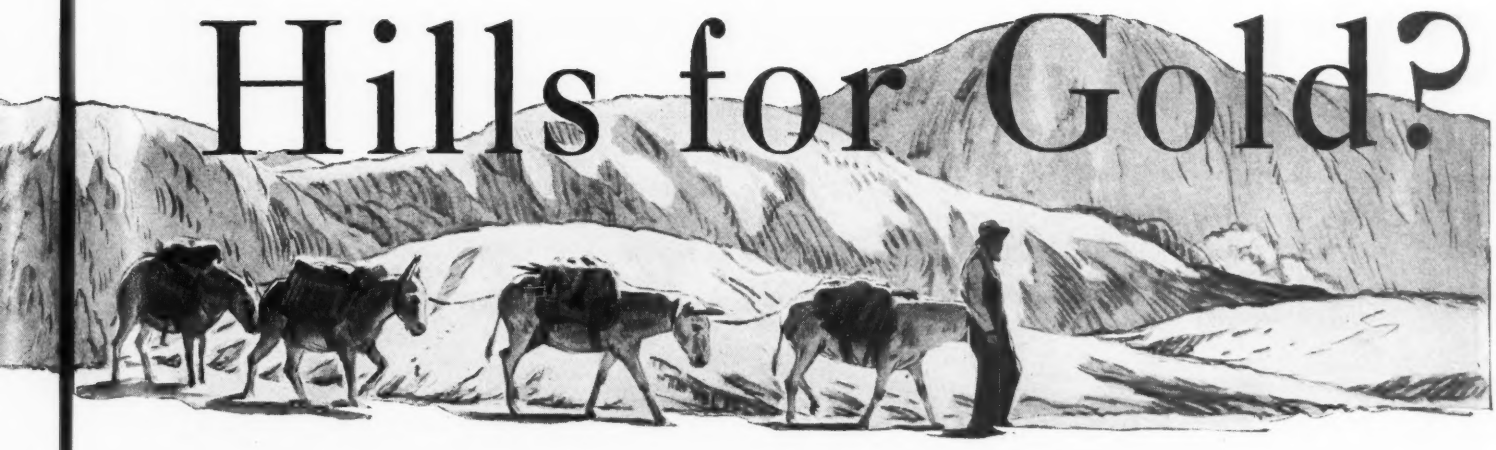
The University, the Kansas Electric Power Company, and General Electric found, on making a survey,



NRA MEMBER U.S. WE DO OUR PART

GENERAL ELECTRIC

Hills for Gold?



that power could be purchased during periods of warm weather to especial advantage, while the use of a noncondensing turbine would provide new economies during cold weather.

Superintendent E. G. Bayles writes: "Our annual operating costs have been reduced 40 per cent, the turbine alone saving more than $7,000 yearly."

NEW MOTORS SAVE PAPER MILL $3,800 ANNUALLY

The California Fruit Wrapping Paper Mills, Inc., found that it could save $3,800 annually on its power bill by modernizing with G-E motors and control. Mr. F. O. Fernstrom writes: "We find the expected savings have been exceeded and represent thirty-four-per-cent return on the investment."

INVESTED AT 70 PER CENT

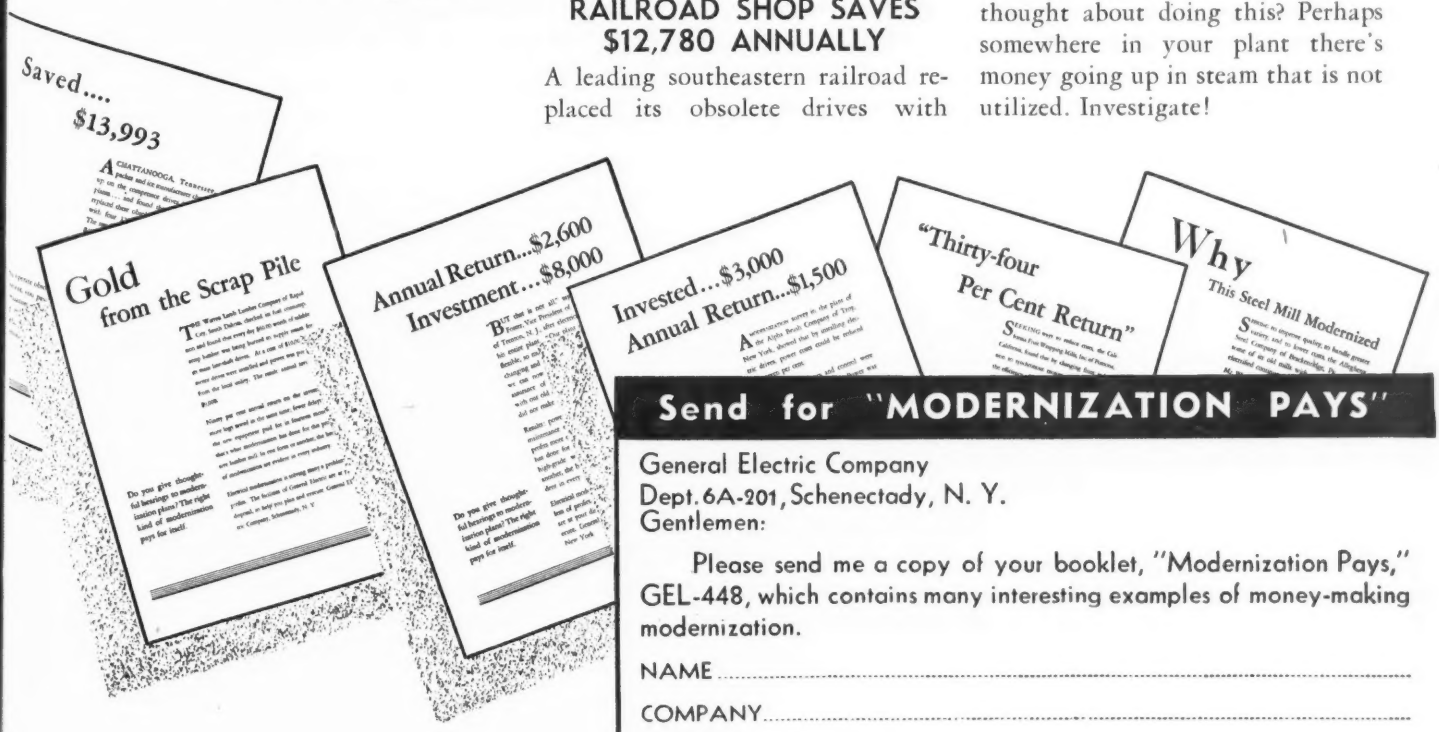
The North Carolina Finishing Company replaced its old power-plant equipment with a G-E turbine to provide power and process steam. Mr. Julian Robertson, general manager, says: "Installation cost was $19,200 including engineering, and under present operating conditions the saving is at the rate of $13,500 annually. In figuring this saving, we have included the cost of labor for operating the turbine and a generous allowance for depreciation of the equipment."

RAILROAD SHOP SAVES $12,780 ANNUALLY

A leading southeastern railroad replaced its obsolete drives with General Electric motors and control. Modern synchronous-motor-driven compressors were installed, and power was purchased from the local utility company. Result: increased production at lower cost; cleaner, lighter, and better shops; and a fifty-per-cent return on the initial investment.

MECHANICAL-DRIVE TURBINE SAVES $3,761 ANNUALLY

A large New England department store formerly exhausted the steam from its reciprocating engines to the atmosphere. Now, a G-E mechanical-drive turbine utilizes this steam that would otherwise be wasted, and saves $3,761 annually. Have you thought about doing this? Perhaps somewhere in your plant there's money going up in steam that is not utilized. Investigate!



Send for "MODERNIZATION PAYS"

General Electric Company
Dept. 6A-201, Schenectady, N. Y.
Gentlemen:

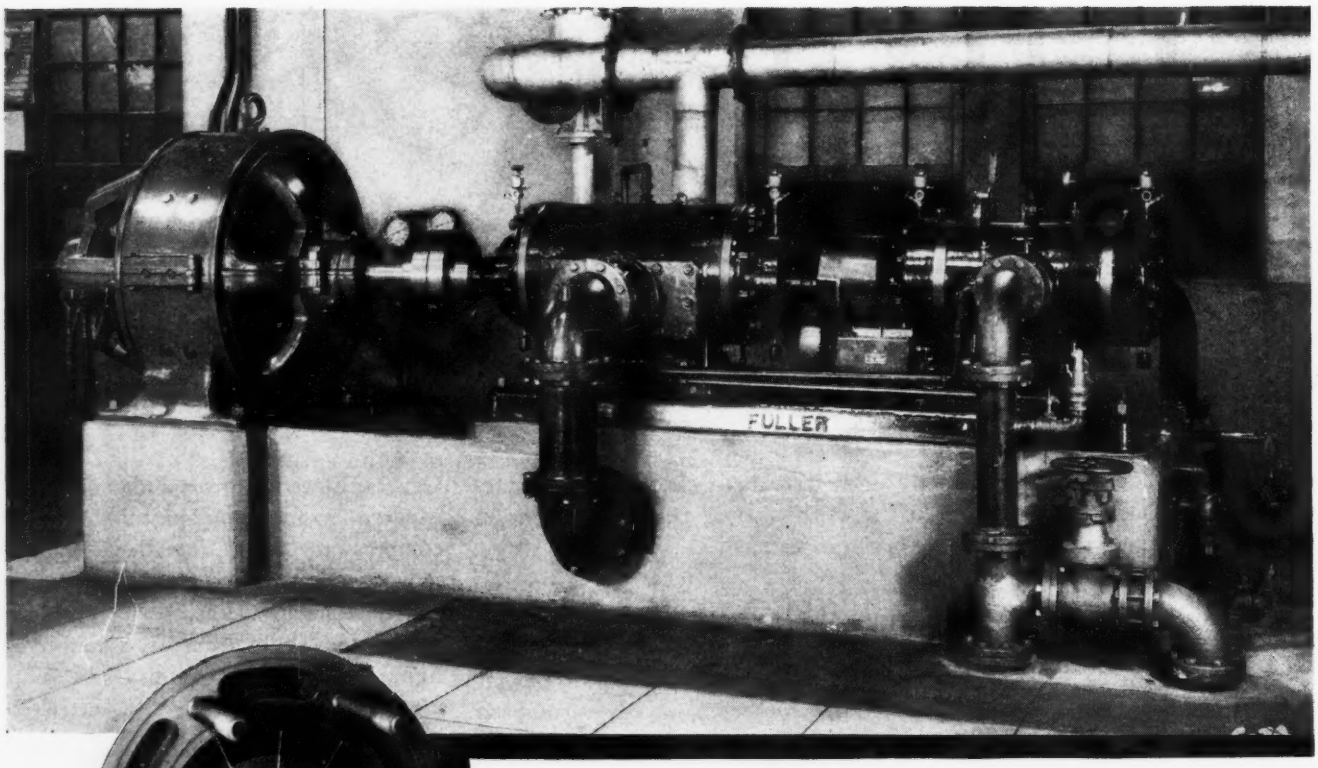
Please send me a copy of your booklet, "Modernization Pays," GEL-448, which contains many interesting examples of money-making modernization.

NAME .....

COMPANY .....

ADDRESS .....

200-791



Compressors need not be complicated–

Two-stage compressor, capacity 1,000 c.f.m. free air, actual delivery, 100 pounds gauge pressure at 575 R.P.M. The insert shows a typical cylinder with the head removed, and the blades in running position.

Fuller Rotary Compressors and Vacuum Pumps have fewer moving parts than any other machines of their type—unique mechanical simplicity, which offers you sustained efficiency and relief from maintenance annoyances. The blades, shown in the illustration, are kept in running position solely by centrifugal force. The patented blade desig and system of lubrication minimizes wear and avoids excessive use of oil.

The 100 pound compressor shown above serves as a stand-by vacuum pump to evacuate condensers on short notice. It is instantly converted to this service by opening two and closing two valves in the lines.

Even if you are not now in the market for compressors or vacuum pumps, we believe you will be interested in our bulletin.

Chicago: 1118 Marquette Bldg.

Fuller Company
CATASAUQUA, PENNA. U. S. A.

FULLER CONVEYORS

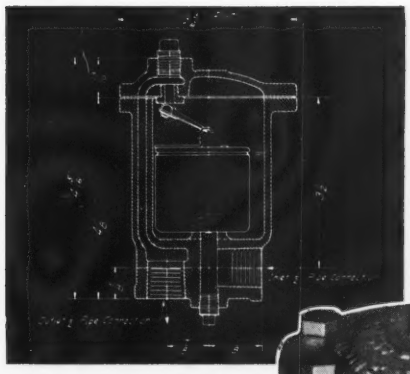
THE AIRVEYOR

is a pneumatic conveyor of fine, crushed and granular materials. It is in wide use for unloading cars, trucks and ships and for general conveying in industrial plants. Our new bulletin illustrates the use of this conveyor in many types and sizes of plants.

FULLER-KINYON PUMPS

for dry, pulverized materials are the most economical conveyors in first cost, installation, power and maintenance requirements. They are standard practice in the cement industry, and are widely used in conveying other fine materials. Write for our new bulletin on Fuller-Kinyon Systems.

Now you can TURN THE CORNER with an ARMSTRONG TRAP



Cross-section at left shows the mechanism of the No. 201 trap—the same as in the No. 200 which has demonstrated its economy and efficiency.

This new No. 201 Armstrong—the latest addition to the greatest line of steam traps—is the same as the No. 200 except for the body. It's only a handful in size but it has an actual capacity between 400 and 700 lbs. of condensate per hour at differential steam pressures between 5 and 80 lbs. per square inch. Maximum pressure handled, 125 lbs. Like the No. 200 it can be furnished with a thermic bucket, giving exceptionally high air handling capacity.

The No. 201 is distinguished by its angle connection which simplifies both new and replacement installations. You can now get the Armstrong high quality trapping service at a low cost and without any piping rearrangement. Just slip out the old and slip in the new. Banish trap trouble and get the maximum out of every pound of steam in heating coils and small steam using equipment. Try this trap at our expense. Use the coupon.

ARMSTRONG MACHINE WORKS

812 Maple Street **Three Rivers, Mich.**

P12Gray

Armstrong Machine Works,
812 Maple Street,
Three Rivers, Mich.

Gentlemen:

Please send me..... Armstrong traps with the new angle connection. I will use them for 90 days and return them at your expense. This involves no obligation.

Maximum steam pressure.....

Approximate amount of condensate per hour .....Type of equipment to be drained.....

Name .....

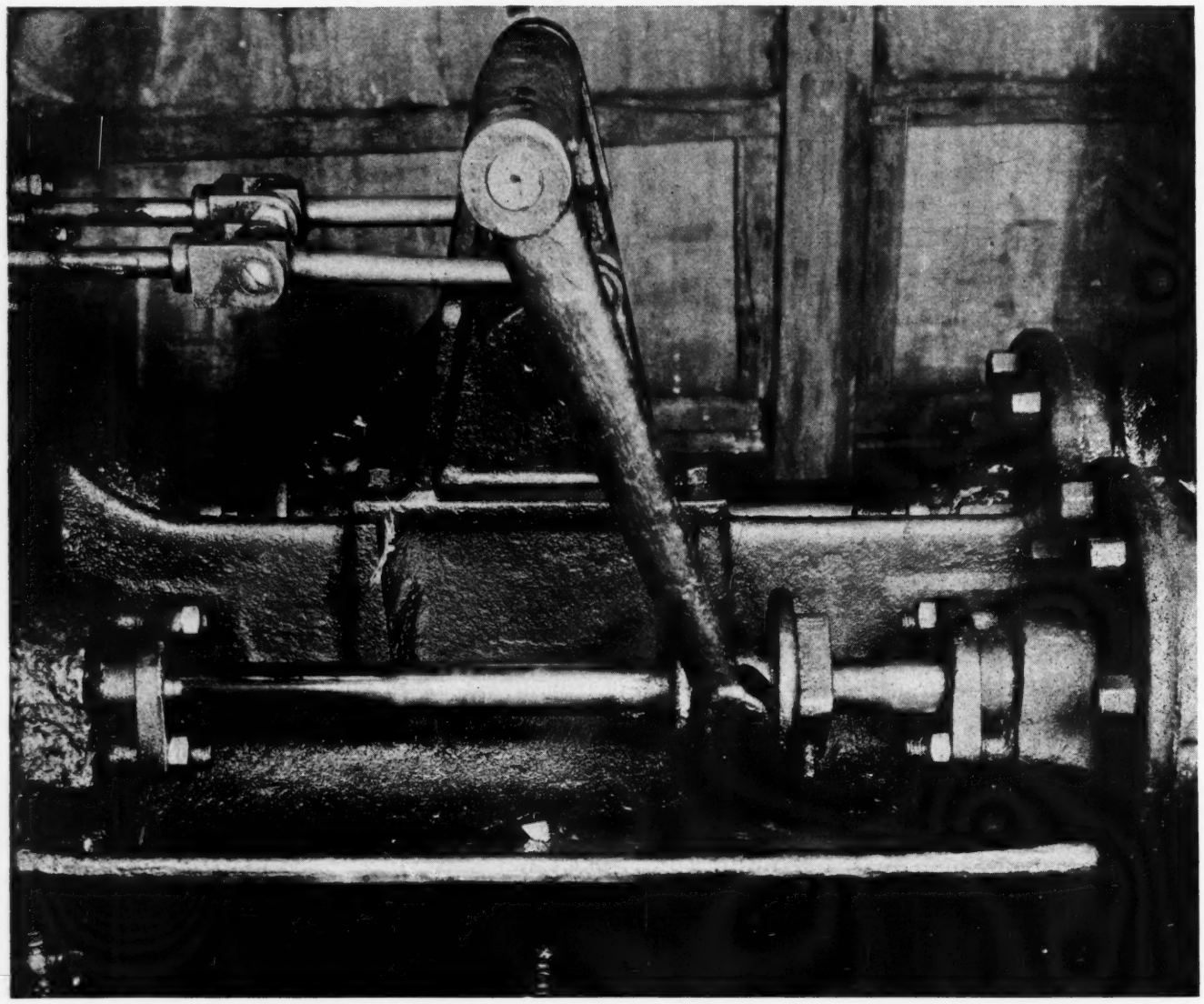
Position .....

Company .....

City .....State .....

You're Wrong, Sir... these Monel Metal pump rods are over 8 Years Old!

● *Monel Metal Pump Rods on both steam and water pistons of 1500 gallon-per-minute Duplex Boiler Feed and Service Pump in tannery of Gutman & Co., Chicago. These four rods have been in service 8 years and are still in perfect operating condition!*



YOU never can tell from the looks of a Monel Metal pump rod how long it has been in service! For example, here the camera says "new"—but the record tells a far different story. These four rods have been on the job more than 8 years each, but all are in practically perfect condition . . . still good for more years of low cost pumping performance.

Sounds remarkable...but not when you consider that these rods are made of Monel Metal. That means they have the enduring strength of steel—with none of steel's tendency to rust. They are highly resistant to corrosive attacks. They will not pit or roughen, but take on a high, glass-smooth polish which saves the packing. They are tough, with a flawless, close-knit structure that never grows tired!

Think of the money these 8-year-old veterans have saved the user. Think of the freedom from repairs and packing troubles they have given. Then...translate this kind of service into terms of your present pumping costs and you'll see why it will pay to learn more about Monel Metal pump rods. Just write.

● Monel Metal is a registered trade-mark applied to an alloy containing approximately two-thirds Nickel and one-third copper. Monel Metal is mined, smelted, refined, rolled and marketed solely by International Nickel.

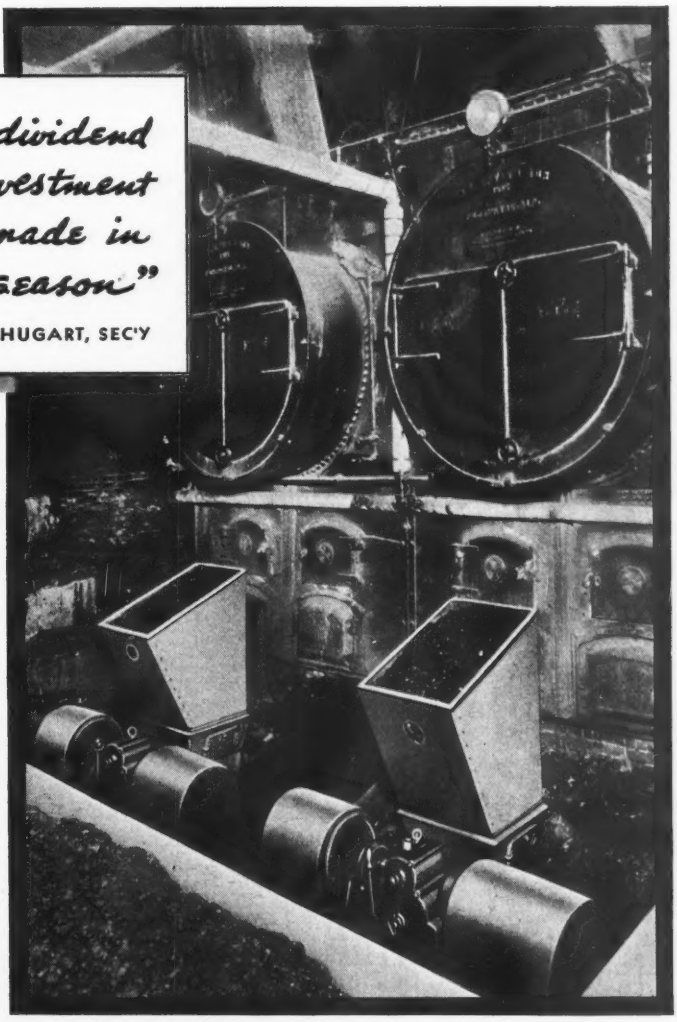
NRA

MONEL METAL

THE INTERNATIONAL NICKEL COMPANY
INCORPORATED
67 Wall Street New York, N. Y.

"Largest dividend paying investment we have made in many a season"

SAYS W. Y. SHUGART, SEC'Y



Iron Fireman stokers under 150 h. p. return tubular boilers at the W. B. Davis & Son plant at Ft. Payne, Alabama.

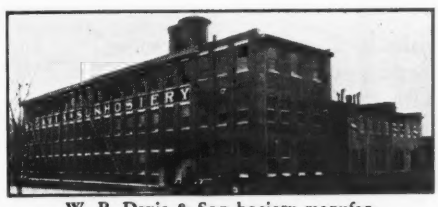
Iron Fireman stokers cut fuel costs 40% for W. B. Davis & Son

● Mr. W. Y. Shugart, secretary of W. B. Davis & Son, hosiery manufacturers, *knows* Iron Fireman. Seven Iron Fireman Automatic Coal Burners are installed at the Davis mills. They are being operated under power boilers, heating boilers, hot water heating boilers, and resident heating.

The performance of the Iron Fireman burners under the 150 h. p. return tubular boilers at the Davis plant is of particular interest to anyone who wants to secure more efficient and economical power plant operation.

Mr. Shugart says: "These units have been installed 2½ years. We have never spent a cent for maintenance. We have been able to use 40% less coal than with hand-firing, and this coal is about 40% cheaper than the fuel formerly used. We have eliminated the smoke nuisance.

"Iron Fireman has at all times maintained a uniform steam pressure. In our Dye Plant we have sudden demands on our power boilers for steam. In such cases our fire comes up to 100% of its efficiency in less than one minute from the time it starts.



W. B. Davis & Son hosiery manufacturing plant, Ft. Payne, Alabama.

"We are frank to say that our Iron Fireman equipment is the largest dividend paying investment we have made in many a season."

In thousands of power plants throughout the country this record of Iron Fireman performance is being duplicated, year after year. In thousands of *other* power plants, where engineers and management are seeking a way to improve efficiency and cut costs, Iron Fireman can achieve similar results.

What will Iron Fireman save in your boiler room? How much will it increase heating or power efficiency? We will be glad to make a free engineering survey of your plant and give you the facts. Please use the coupon.

IRON FIREMAN

Automatic Coal Burner

THE MACHINE THAT MADE COAL AN AUTOMATIC FUEL

IRON FIREMAN MANUFACTURING CO.,
3170 W. 106th Street, Cleveland, Ohio.

☐ Please make boiler room survey ☐ Send literature

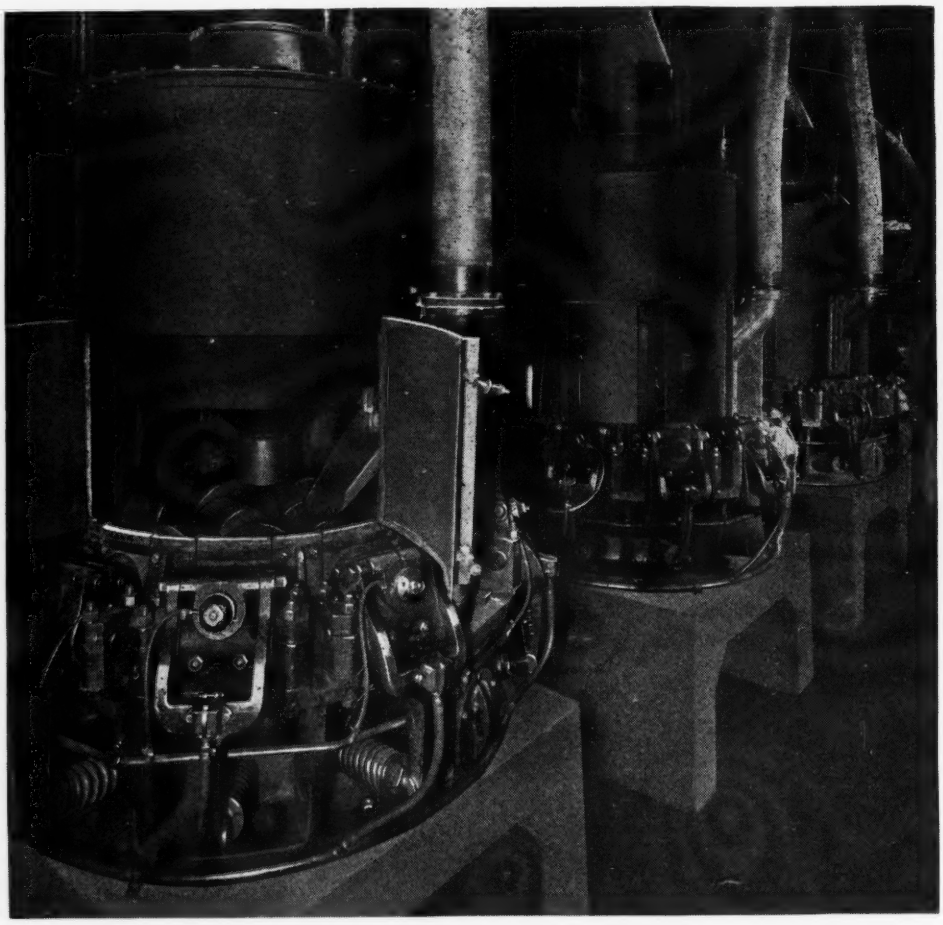
Name.....

Company.....

Address.....P-1

WHITING POWER HOUSE EQUIPMENT

IN STEP BY STEP MODERNIZATION



USING LESS POWER AND CUTTING POWER COSTS

These Whiting Table Roller Pulverizers, over a two-year period, showed an average power consumption of 6.8 KWH per ton of coal fired—including both pulverizers and feeder motors.

In making this record in the boiler room of a large central station in Illinois, these Whiting Pulverizers pulverized 97,311 tons of Illinois coal—high in both moisture and ash content.

Low power cost of the Whiting Table Roller Type is accompanied also by high pulverizing efficiency and low maintenance cost. This combination makes them decidedly efficient and economical units for continuous service in central stations or industrial power plants.

In step-by-step modernization, the place to start is the boiler room—and the place to start there is with firing.

Investigate the high mechanical and firing efficiency of Whiting Pulverizers and Whiting Pulverized Fuel Systems. Our Engineers are ready to co-operate.

WHITING CORPORATION

15657 Lathrop Avenue
Harvey, Illinois

Pulverizer Capacities

Table Roller Types

3 tons per hour
7 tons per hour
12 tons per hour

Impact Type

300— 700 lbs. per hour
500—2000 lbs. per hour
1000—3500 lbs. per hour

Bin or Storage Systems
Pneumatic Conveying Systems
Coal Feeders
Burners, Fans and Piping
Stokers
Transformer Cars
O. C. B. Hoists
Electric and Hand Power Traveling Cranes

WHITING PULVERIZERS

NRA MEMBER U.S. WE DO OUR PART

It cost $42 to repair this block insulation job. *It would have cost less than $10 if the insulating material had been EAGLE "66" Insulating Cement*

• The photograph above shows a large hot water storage tank, that has been insulated with Block insulation. One end of this tank leaked, resulting in considerable damage to the insulation, and the necessity of removing the insulation in order to make repairs.

The entire insulation on the end of the tank (approximately 100 square feet) was wrecked. To repair the block insulation after the tank was fixed, cost actually $42. If the tank had been insulated with Eagle "66" Insulating Cement, repairs to the insulation would have cost less than $10.

It isn't often that we happen to be on hand and catch a photograph of a job like this. We offer it as a case in point, to prove by contrast one of the advantages of good plastic insulation made with Eagle "66".

We make all kinds of heat insulation — including pipe covering, blanket insulation, blocks, insulating cement, waterproofing cement, boiler setting cement, etc.

SEND THE COUPON — if you would like a free sample of Eagle "66" and book describing its new principle of "springy ball" construction.

ADVANTAGES OF PLASTIC AS AGAINST BLOCK INSULATION —WHEN EAGLE "66" INSULATING CEMENT IS USED

1. Plastic Insulation sticks to a hot surface, becoming an efficient, one-piece insulation—with no seams or joints to open up to escaping heat. Blocks often pull away—shrink and open up.

2. Eagle "66" Cement offers greater ease and economy of application. Can be applied often for one-half labor cost of Block, using your own workmen. This gives greater control over work, as well as economy. Cement goes on easier around corners and over irregular surfaces.

3. With Cement only one material is needed — and *no* special tools. With Blocks you need several accessories — including a finishing cement.

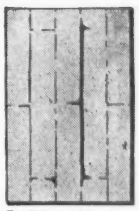
4. After it is applied, Eagle "66" is several times stronger than a section of Block.

5. Repairs, changes and alterations are much easier and less expensive with Eagle "66".

6. No loss from breakage with Eagle "66".

7. Eagle "66" is 100% reclaimable.

8. With all these advantages, Plastic (with Eagle "66") is no more expensive than Block.



1. With Blocks, seams and joints are liable to crack open, letting out heat.

2. Plastic forms a continuous, one-piece insulation.

3. Blocks tend to pull away — do not fit tightly. Heat escapes through openings.

4. Plastic sticks to hot surface — over irregularities such as riveting.

The Eagle-Picher Lead Company, Dept. P12, Cincinnati, Ohio
Please send me your free sample and booklet about Eagle "66" Insulating Cement.

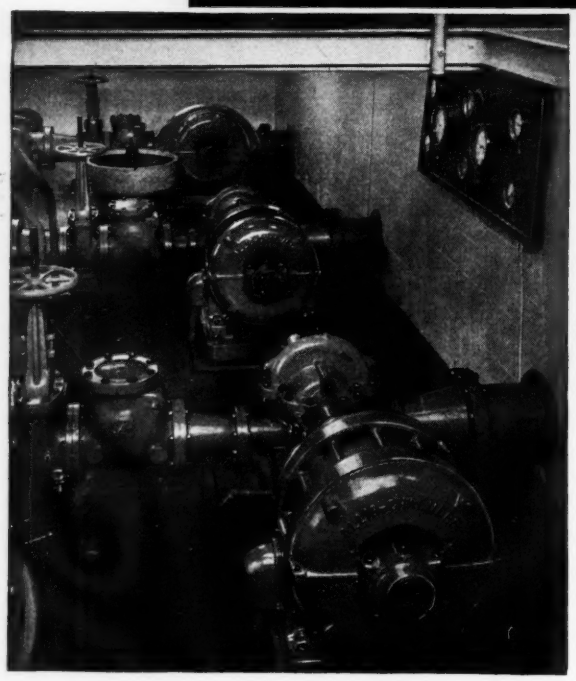
*Name*_____

*Firm*_____

*Address*_____

EAGLE "66"

Insulating Cement — embodying the new principle of "springy ball" construction



ABOVE — Allis-Chalmers 20 mgd 310 ft head pumping unit with 1250 hp Allis-Chalmers Synchronous Motor recently furnished to District of Columbia as the first unit in electrifying an old steam plant. The performance of this unit earned a bonus on acceptance test.

BELOW — Allis-Chalmers Centrifugal Pumps and Motors in the Pumping Station of the City of Wauwatosa, Wisconsin, which effected a material saving in the cost of pumping.

Modernize ... with Good Pumps they pay for themselves

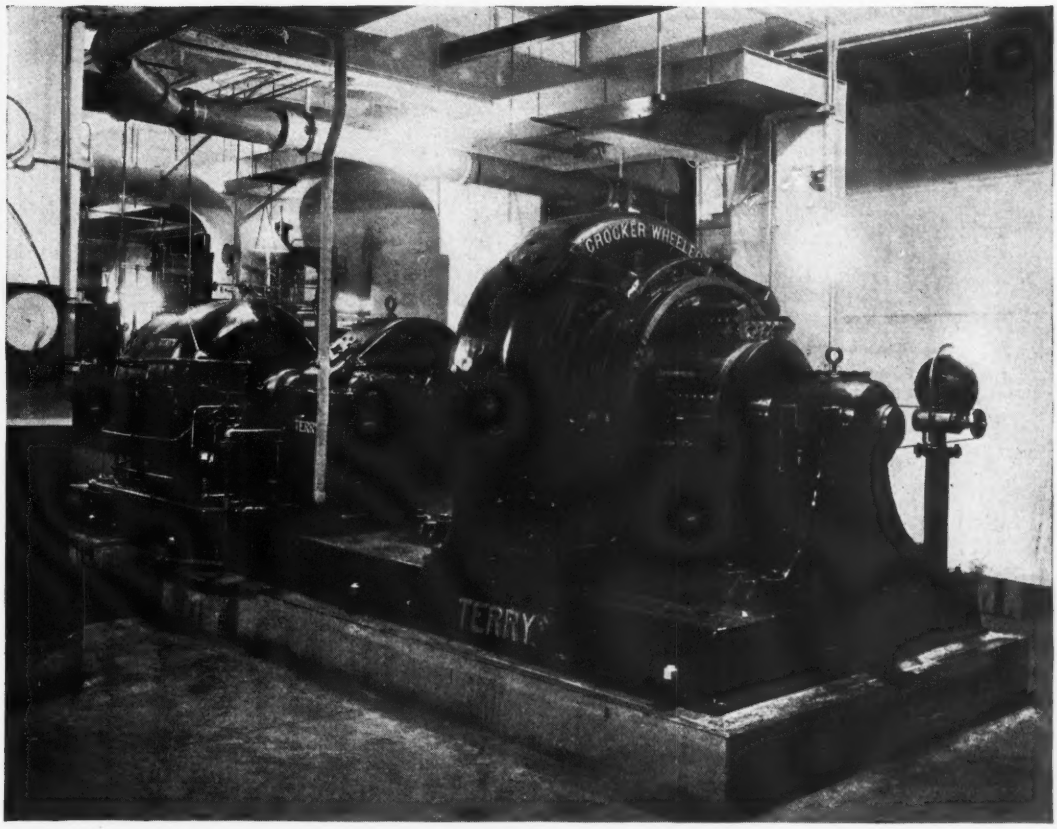
THE large quantity of water which can be delivered by the relatively small centrifugal type of pumping units together with recent improvements in details of design materially lowering the power required for the drive and correspondingly reducing the cost for current, present interesting possibilities in pumping plant rehabilitation or when increased capacity is needed. Where equipment is to be paid for out of earnings, only high grade pumps can be considered and those which have sustained high economy and low maintenance. Allis-Chalmers Combined Centrifugal Pumping Units have long been recognized as having these qualities.

Write for Bulletin 1650.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee

TERRY



THIS TERRY TURBINE SAVES NEARLY HALF ITS COST EACH YEAR

This 750 K.W. Terry Mixed Pressure Turbine is installed in the power plant of Runkel Bros. Inc., chocolate manufacturers of New York.

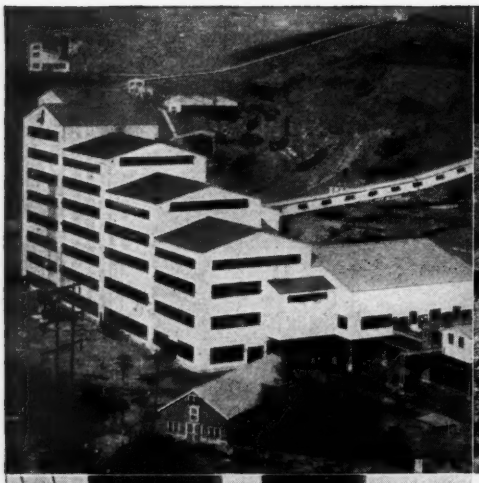
Before the turbine was placed in operation $30,000 worth of reciprocating engine exhaust steam was wasted each year.

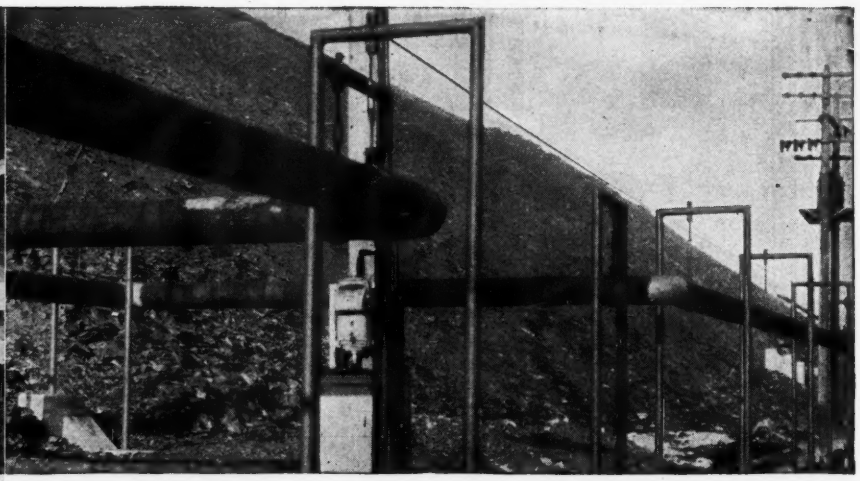
Now this steam is mixed with high pressure steam to produce 460 K.W. of reliable power. The yearly saving amounts to almost half the entire cost of installation.

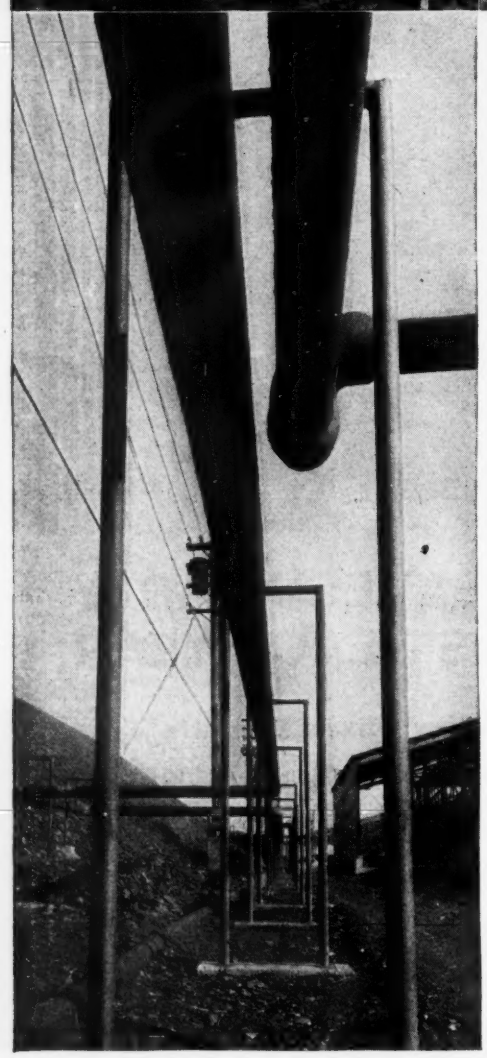
Let us figure what a Terry turbine can do in your plant.

The TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.
Steam Turbines - Gears - Shaft Couplings

T-1061







The design and construction of the entire operation was under the supervision of Stone & Webster Engineering Corporation.

8500 FEET OF ALL WELDED HIGH PRESSURE STEAM LINE

Two 450 lb. steam lines of 8 in. extra heavy genuine wrought iron pipe in 20 ft. lengths, all field welded by the Kellogg "Masterweld" method, connect the central breaker and two mine shafts, with the power plant of the Philadelphia & Reading Coal & Iron Company, St. Nicholas, Penna.

It is an excellent example of field welding as developed by the Kellogg "Masterweld" method of coated electrode fusion welding.

This installation is one of the largest high pressure steam transmission lines in connection with a central boiler plant, thus far constructed.

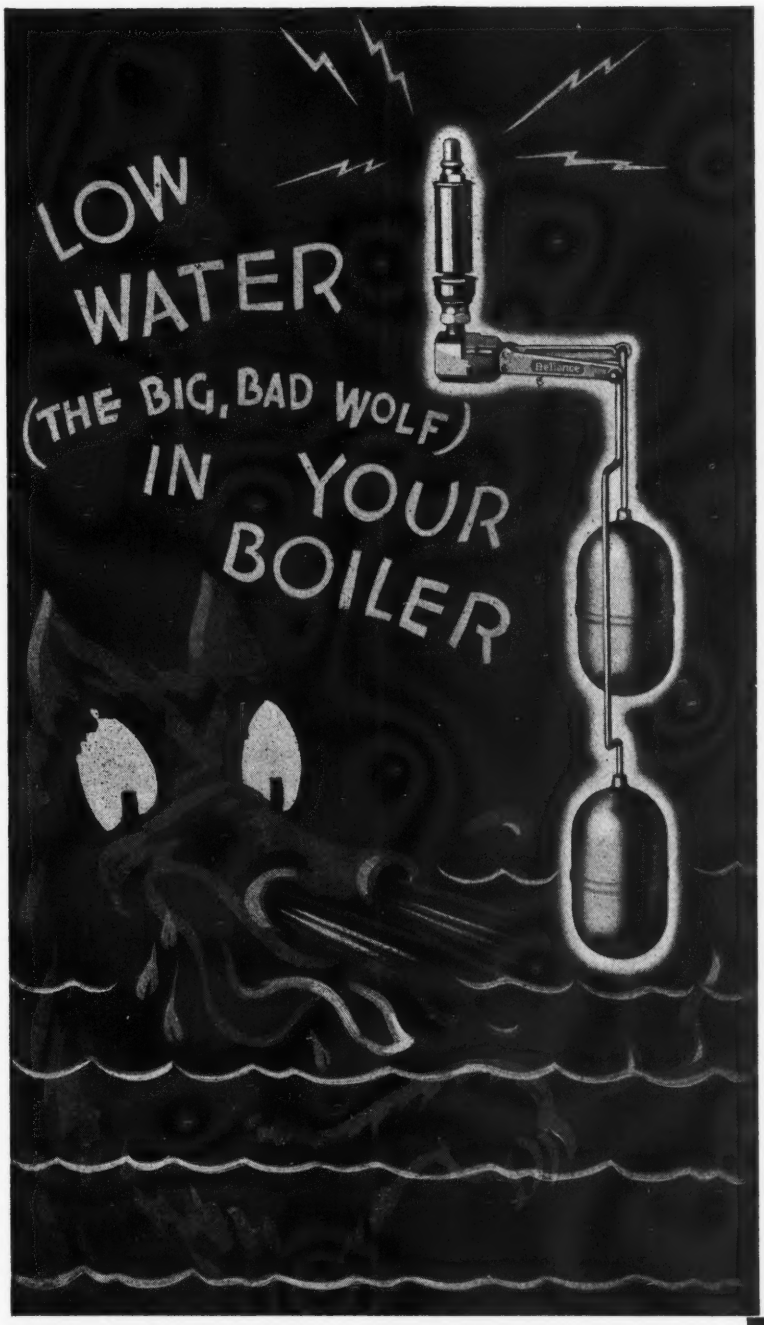
Our engineers will be glad to discuss the application of Kellogg "Masterweld" to your problems.

THE M. W. KELLOGG COMPANY · 225 BROADWAY, NEW YORK

Birmingham, 827 Brown-Marx Building · Chicago, 1 La Salle Street · Los Angeles, 1031 South Broadway · Tulsa, Philtower Building

KELLOGG

Kellogg products include: Cross, Holmes-Manley, deFlorez and Tube and Tank cracking units, absorption plants and pipe stills. Pressure vessels for the Power, Refinery and Chemical Industries. Power plant and Industrial piping. Pacific Hot Oil Pumps, Radial brick chimneys. Plastic Refractories.



There is

NO SUBSTITUTE

for

QUICK SURE ACTION

WHEN there's a low water emergency in your boiler, you need action — instantaneous hair-trigger action. No slow hesitating alarm will do. There must be an immediate blast from the whistle or warning from the electric alarm, to bring the boiler attendant on the run. . . . That's the prompt action Reliance float-operated safety water columns have been giving for 50 years. Not once have they failed to meet an emergency!

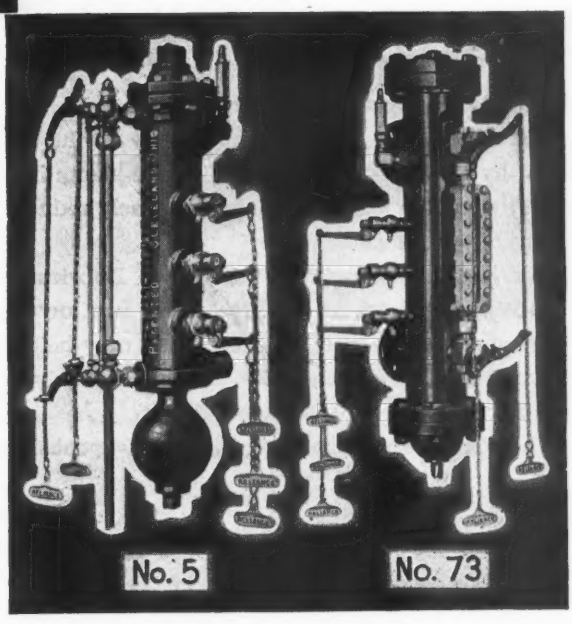
Reliance Floats Are Unsinkable

MODERN engineering eliminates old bugaboos. The Reliance fused-monel float simply doesn't waterlog or leak or sink. It's as perfectly reliable as if it were made of solid metal. Thousands upon thousands of them, under fire every day, are ample proof of it. But being extraordinarily buoyant, they give the highly sensitive response so necessary in a safety device. They act instantly—which is 95% of any real safety. Specify Reliance and you **know** that your boilers are under alert, wholly dependable guardianship.

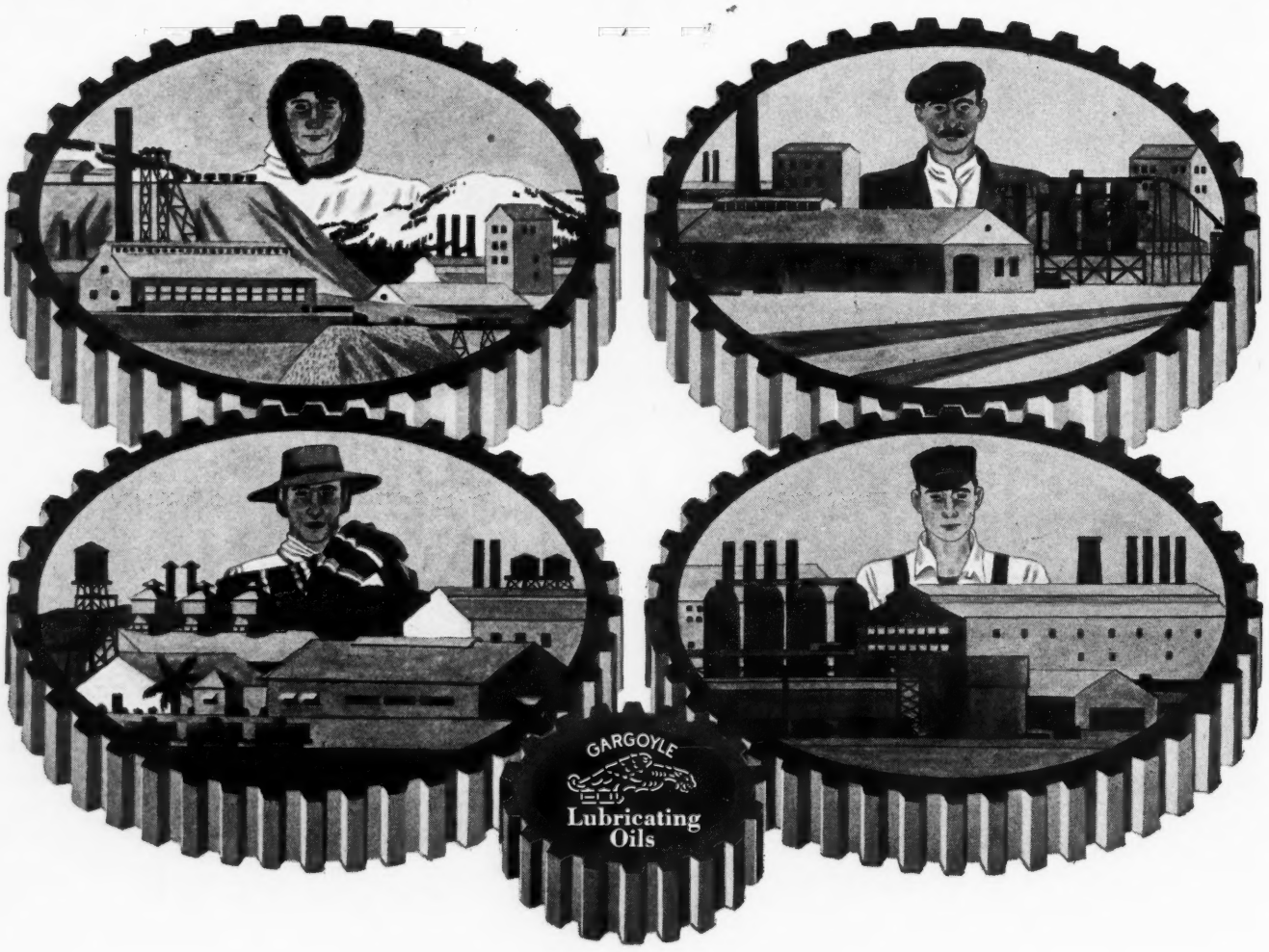
THE RELIANCE GAUGE COLUMN CO.
5924 CARNEGIE AVE., CLEVELAND, OHIO

Reliance
TRADE MARK REG. IN U.S. PAT. OFF.

SAFETY WATER COLUMNS



WORLD-WIDE . . . AND IN YOUR PLANT



A Vital Cog

in cost control

Today, labor costs are higher! Raw material costs are higher! Selling costs are higher! Now is the time to profit by the experience of world-wide plants in every industry and let Gargoyle Lubricants help reduce your major *plant* costs.

For, in your plant, too — Gargoyle Lubricants can reduce power costs 3% to 10%. They can lower your maintenance and repair expense. They may help speed up your production schedules. They'll certainly insure you against machinery shutdowns.

The cost of lubrication is a trifling one — probably less than 1% of your total costs of conversion. Yet this seemingly insignificant item controls major costs in your plant. Plant records, written in every language, prove that Gargoyle Lubricants *can easily save you many times your total annual cost of oil.*

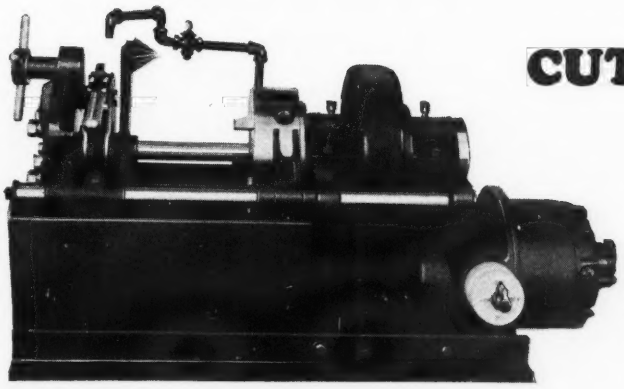
Any Socony-Vacuum representative will be glad to show you lower-cost records made by leading plants in your own industry . . . to suggest means by which you can lower today's costs in *your* plant.

Socony-Vacuum Corporation, 26 Broadway, New York City. Branches and distributors throughout the world.

SOCONY-VACUUM
CORPORATION

NRA MEMBER U.S. WE DO OUR PART

2 INCH PIPE—



CUT OFF THREADED AND REAMED IN LESS THAN 1 MINUTE

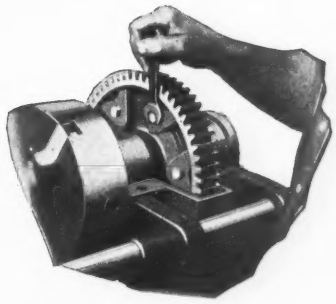
"Toledo" No. 999 ½" to 2" Pipe Machine

From all angles the No. 999 is better suited for your quick repairs or general maintenance work.

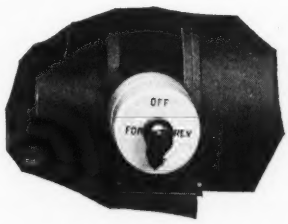
Speed beyond the average requirements. Simple to operate. Sturdily built for long service. Patented features exclusive on the No. 999, all tend to make the No. 999 the ideal small pipe machine.

Strictly portable, easily taken to the job. Carried by two men. Passes through an ordinary door.

You can't go wrong on a No. 999. Ask any user. see one demonstrated. Widespread approval has made the No. 999 the most popular small pipe machine today.

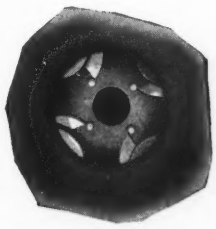


Safety friction gear protects machine from overload. Six cap screws easy to adjust under spindle cover.

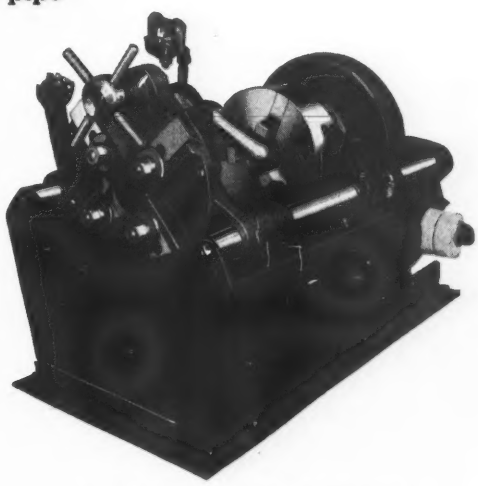


No gears to shift.
All controls centralized in starting switch in easy reach of right hand.

Separate Quick-opening die head for each size.
Instant die change assured.
Die heads adjustable for various depth threads.



Specially designed four blade cutter head. Cuts off pipe easily and quickly. Knives are set as shown above with small gauge furnished.



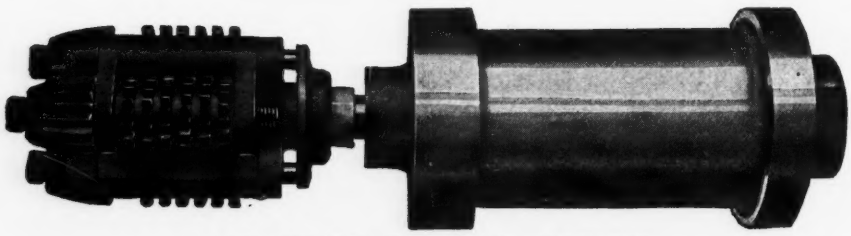
Note reamer swung back out of position when not in use.

THE TOLEDO PIPE THREADING MACHINE COMPANY
TOLEDO, OHIO. NEW YORK OFFICE & DISPLAY ROOM, 72 LAFAYETTE STREET

"TOL·EDO"

DIRTY TUBES WASTE MONEY

Clean tubes insure maximum exchange of heat . . . save both fuel and labor



Roto Heavy Duty Type for 3½-4" Straight Tubes
Featuring the Roto Swing Frame Head

You can have perfectly clean tubes, at low cost, with Roto Tube Cleaners —in heat exchangers of all kinds, boilers, economizers, stills, etc.

Catalog describing complete line of Roto Cleaners for all purposes sent on request.

THE ROTO COMPANY
SUSSEX AVE. AND NEWARK ST., NEWARK, N. J.

FISHER

FOR OVER
FIFTY YEARS
THE MARK OF SCIENTIFIC FLUID CONTROL

TYPE ST
INVERTED BUCKET
STEAM TRAP

Positive Operation-Large Capacity-Most Economical

FISHER CONTROL SPECIALTIES
PUMP GOVERNORS
REDUCING VALVES • RELIEF VALVES • LEVER & FLOAT VALVES • STEAM TRAPS
LIQUID LEVEL CONTROLS
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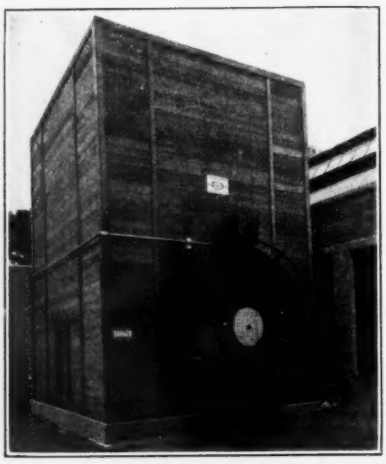
A WELDING technique developed through years of practice; comprehensive laboratory facilities for testing; a specially designed X-Ray machine to prove soundness; and a large stress relieving furnace assures maximum strength and serviceability of any HOMOWELD vessel for the refinery, chemical, or power field.

Bulletin W-1 completely describes Vogt HOMOWELD and may be had upon request.

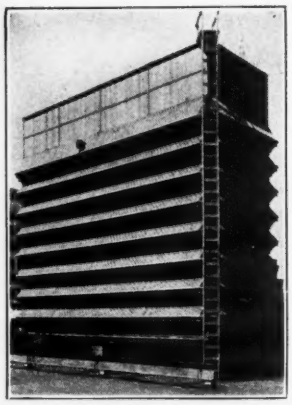
HENRY VOGT MACHINE CO.
Incorporated
LOUISVILLE, KY.
NEW YORK, CHICAGO, CLEVELAND, PHILADELPHIA, DALLAS
Manufacturers of: Oil Refinery Equipment, Drop Forged Steel Valves and Fittings, Water Tube Boilers, Ice Making and Refrigerating Machinery Heat Exchangers

ACHIEVEMENTS

IN COOLING EFFICIENCY



1. The Marley patented spray nozzle, used in all Marley cooling systems.
2. The Marley spray tower with positive, effective water distribution and simple, inexpensive design.
3. The Marley spray deck tower with patented louvred louvre, controlled air flow and improved deck design.
4. The Marley forced draft tower with spray distribution, slow speed, quiet Multi-blade fans and multiple effect drift eliminator.



Illustrating typical Marley towers. Above, the forced draft; right, atmospheric deck type.

Marley patented spray nozzles are standard equipment in all Marley cooling systems.

These improvements make Marley cooling systems more efficient and more economical. Write for full details. Submit **your** cooling problem for free estimates and recommendations.

THE MARLEY COMPANY
1915 Walnut **Kansas City, Mo.**

MARLEY
COOLING SYSTEMS

A good name to remember when Boiler Tubes are requisitioned.

BOILER TUBE COMPANY OF AMERICA

Main Office and Works:
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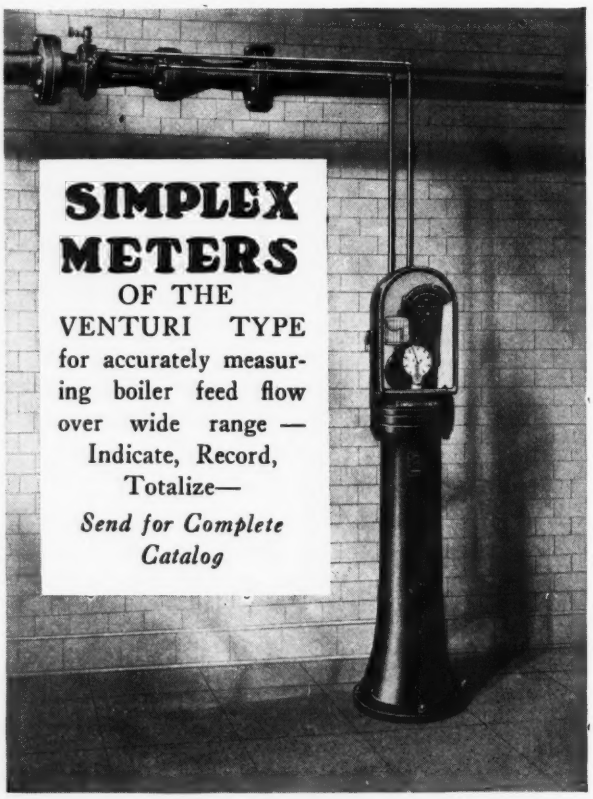
Straight and Bent Tubes for all Types of Boilers.



SIMPLEX METERS
OF THE VENTURI TYPE
for accurately measuring boiler feed flow over wide range — Indicate, Record, Totalize—
Send for Complete Catalog

Simplex Valve & Meter Co.
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AUTOMATIC CUSHIONED-STEAM AND WATER SERVICE VALVES

Triple Acting Non-Return Valves; Plain Non-Return Valves; Steam Reducing Valves; Relief Valves; Water Reducing Valves; Float Valves; Double Cushioned Check Valves.

"EVERY VALVE SOLD WITH AN ABSOLUTE GUARANTEE"

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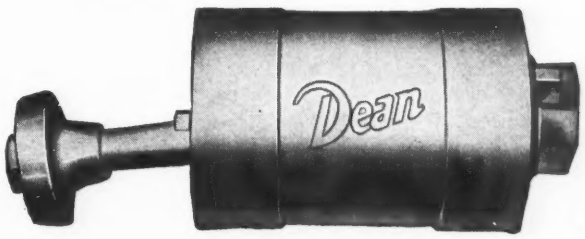
DO YOU KNOW—

—that for more than thirty years, every Dean Boiler Tube Cleaner has been purchased under an iron-clad *guarantee* as to the savings it would produce?

—And that the guarantee is made to every purchaser regardless of his use of *any* other method intended to remove or prevent boiler scale?

CONSIDER and INVESTIGATE THESE FACTS! *Write for further particulars*

The totally different *Vibratory* Cleaner. More thorough, rapid and durable in all types of boilers and tubes



THE WILLIAM B. PIERCE CO., Caxton Bldg., Buffalo, N. Y.

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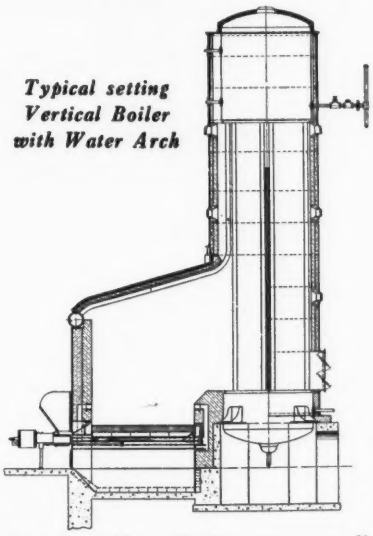
"RECOGNIZED QUALITY"

Typical setting Vertical Boiler with Water Arch



A water arch provides effective water cooling in the furnace that is inexpensive. It can be applied to both old and new boilers.

Wickes products include all types of boilers, fusion welded or riveted.

THE WICKES BOILER CO

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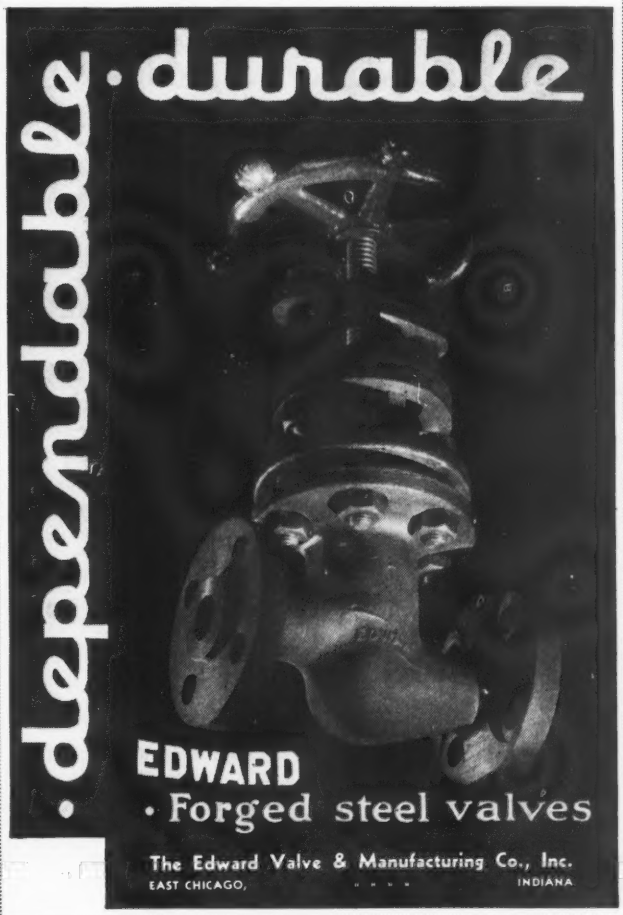
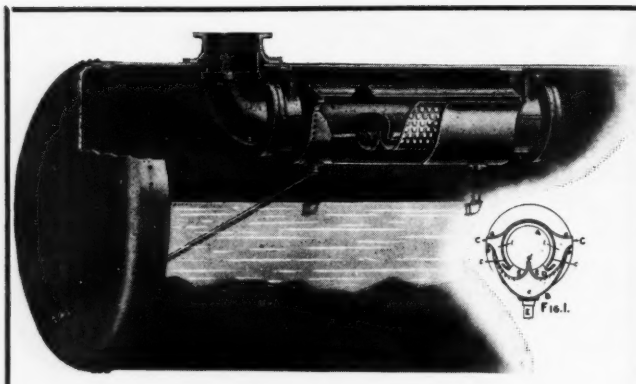
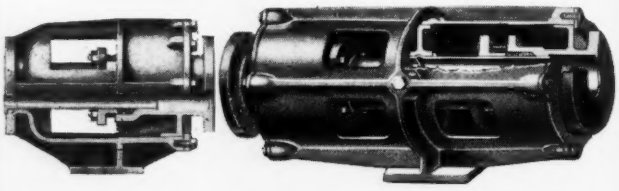




TAKES THE DIRT AND WATER FROM STEAM IN BOILER

This Separator has been on the market for 20 years. It is so designed, the areas are so liberal and the draining so effective, that there is no "wire-drawing" of steam even after Separator has been in service a long time. Note drain to outside of boiler. Let us tell you more about it.



EXPANSION JOINTS THAT CANNOT GET OUT OF ALIGNMENT

Stuffing box and guides form the sliding member —external guide is in the one-piece, substantial, cylindrical casting that extends the full length of joint. Misalignment is impossible.

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STEAM SEPARATORS
OIL SEPARATORS
COMPRESSED AIR SEPARATORS
FLANGED FITTINGS

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SYRACUSE, N. Y.

SPEED INDICATORS that don't wear out!

THE Frahm Tachometer has ***no wearing parts;*** it requires no oiling. It consists of a set of accurately tuned reeds which respond by resonance to the slight vibration caused by the rotation of the machine against which it is held or on which it is mounted. It requires no belts, gears or electrical connections and costs little or nothing to install.

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Please write for descriptive Catalog 1240-P.

JAMES G. BIDDLE CO.
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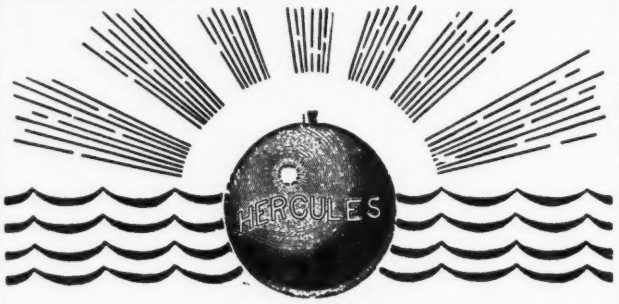

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Not when HERCULES Seamless Copper Floats are used to maintain the water level in heaters, tanks, reservoirs and other appliances.

The special spinning process assures uniform thickness of metal and high mechanical strength. Every Hercules Float is guaranteed to stand up under 350 lb. working pressure and 500 deg. temperature.

Ready to ship—all ball shaped sizes to 10 in. inclusive. Special shapes or sizes furnished promptly on order.

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Why Do Leading Public Utilities Companies and Industrial Companies Specify **Kennedy Pulverized Fuel System?**

The Answer is

Simplicity . . . Reliability . . . Durability

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What is the ratio of your steam cost to that of your finished product? There is a substantial saving possible by the use of the KENNEDY SYSTEM.

The KENNEDY PULVERIZED FUEL SYSTEM excels on all grades of fuel, enabling you to produce steam at a cost far below that obtainable with other systems.

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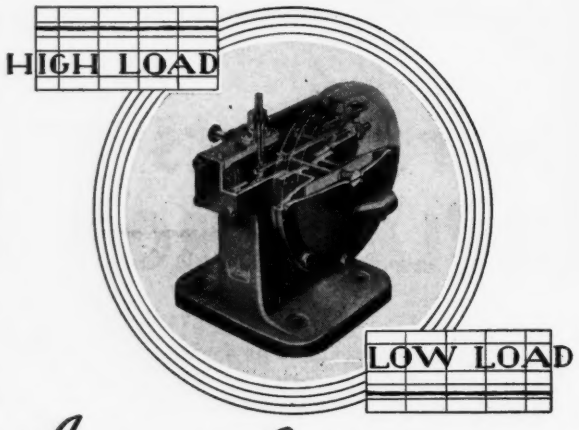

Askania Control *is equally*

TRUE *and* UNIFORM

Regulation by means of the Askania System is fully metered, continuously responsive to the regulating impulse and governs throughout the entire working range without adjustment or attention. For details write to.....

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•TURBOIL

THEY will agree that it is THE PIONEER TURBINE OIL—used in the Largest units (160,000 k.w.)—in the Smallest units, and the Newest or Oldest types—ANY MAKE!

They will tell of TURBOIL in their systems, without discard, and with only normal makeup, for 21 years; for 17 years, or terms of 9 or 7 years—as easily at that!

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VALVES

SLASH *Air Preheater* CORROSION COST

REVERSIBLE CHAMBERS GIVE DOUBLE LIFE!

No need to tear apart this Sturtevant Air Preheater and junk the chambers...when corrosion attacks the exit end.

Chambers are readily accessible...and *removable* and *reversible*. Individual corroded chambers can be slid out, reversed, put back with uncorroded ends up.

You get *double* the usual preheater life. No costly dismantling. No large labor bills. No long preheater shut-downs.

Investigate this big economy in air preheater operation.

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Air Preheaters

GET MORE WORK OUT OF OLD EQUIPMENT

Why let your present steam-heated equipment waste money by operating at 50 to 75 percent of its possible efficiency due to wet steam or air binding? If furnished with a continuous supply of hot, dry steam, presses, kettles, dryers, cookers, or any steam-heated equipment using coils or jackets will do far more work at a lower cost.

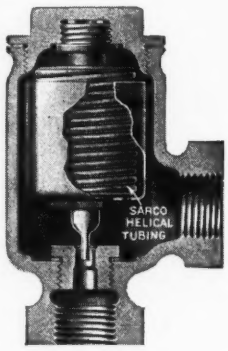
Trap every piece of equipment with a separate Sarco Steam Trap. Then air will be vented and condensation discharged as fast as formed.

SARCO STEAM TRAP

assures a steady flow of hot, dry steam.

Condensation in heating coils and the like cuts down the volume of steam and heat transfer efficiency.

If air is not removed, condensate cannot get to the trap and it ceases to work. Not only does the condensate back up into the system, but air mixed with steam cuts down the heat transfer capacity of the steam.



With individual Sarco Traps, no water will be held up in the coils of one unit by back pressure in the return piping from another unit, as happens with large centrally located traps.

Send for a free copy of Booklet A-95.

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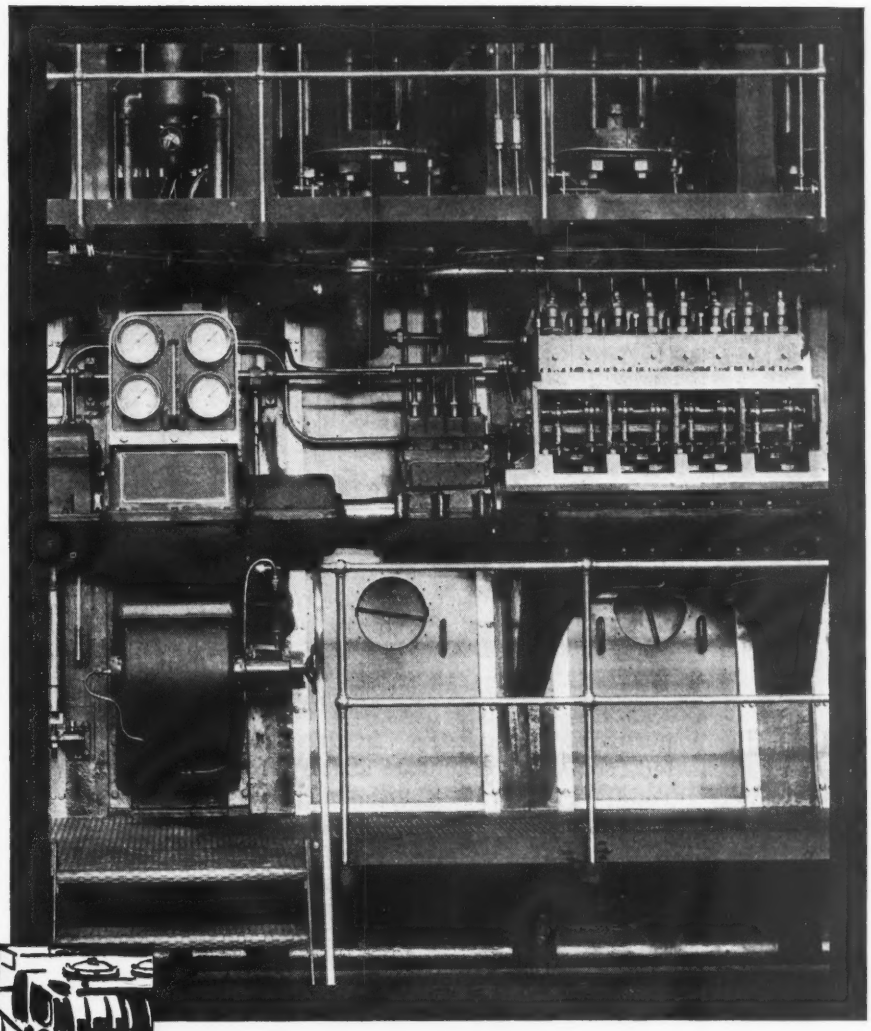
Branches in Principal Cities

Sarco Canada Limited, Federal Bldg., Toronto Ont., Canada

TEXACO URSA OIL

chosen for the country's greatest

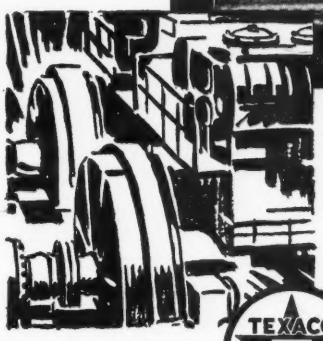
Diesels . . .



TEXACO URSA OIL lubricates the cylinders of the 35,000 h.p. Diesel plant of Vernon, California. These are the largest Diesel engines ever built in America. Naturally, the lubricant to be used for the cylinders was one of the important questions for the Chief Engineer and engine manufacturers to decide.

These men had confidence in Texaco and they chose TEXACO URSA OIL for this major service. Performance has been excellent.

In this great plant, as in hundreds of others, TEXACO URSA OIL is making exceptional records for lubricating effectiveness, freedom from carbon and resistance to extremes of temperature and pressure. It is a remarkable oil for heavy-duty Diesel engine lubrication.



Try it. TEXACO URSA OIL is made in a viscosity grade for every type of engine. Texaco engineers stand ready to help you with any problem of Diesel lubrication. Write The Texas Company.

THE TEXAS COMPANY

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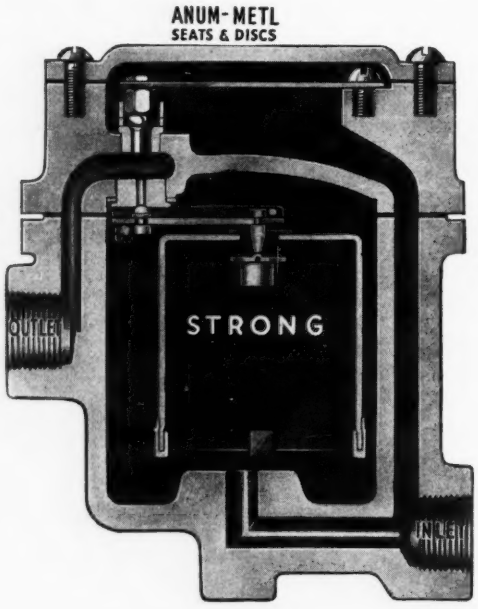
TEXACO LUBRICANTS

Quality

INVERTED BUCKET TRAPS IN THE SMALLER SIZES



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No. 70-T Trap

The No. 70-T trap combines the inverted bucket and the thermostatic trap principles. In this trap the air is separated from the condensate at the inlet and handled through a separate thermostatically operated valve. Especially adapted for jobs requiring the rapid elimination of a large volume of air, such as: cookers, dryers, unit heaters, pipe coils, etc., etc. Built for pressures from 0 to 125 pounds.

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Guaranteed Leak-proof for One Year
Wear-Proof Parts

A clearance between the hole in the bucket and the spindle provides the air vent. The up-and-down movement of the bucket, in discharging, keeps the air vent from becoming clogged.

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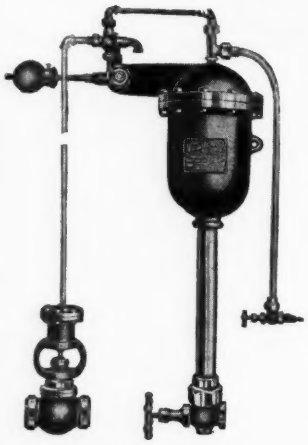
of a complete line of steam traps and other steam specialties.

It Never Sleeps —Never Lapses



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Feed Water Regulator

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HUMAN attention and care in feeding a boiler cannot possibly approach the uniformity with which the "Vigilant" will hold the water level once you have installed the Vigilant Feed Water Regulator. Perfectly automatic, simple, accessible, unfailing, the **Vigilant** eliminates a serious hazard, gives better steam production, and lowers fuel cost. Write for full information.

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Manufacturers also of the Fulton Pump Governor, Tank Governor, Reducing Valve, and other Fulton Steam Specialties.

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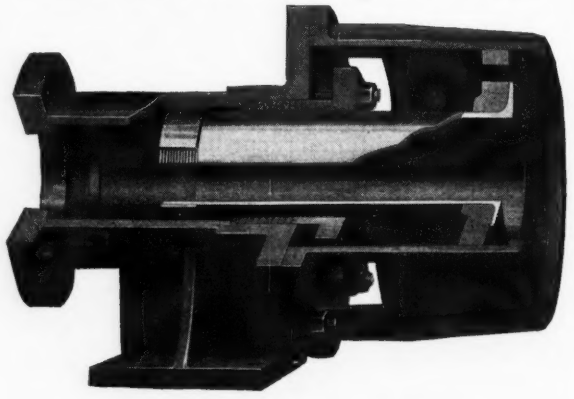
EXPANSION JOINTS



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There is an ADSCO Expansion Joint for every piping job.

Single or Double Slip
Internally—Externally Guided
Positive Limit Stops
Dependable Always
Also Packless Expansion Joints for all pressures and temperatures

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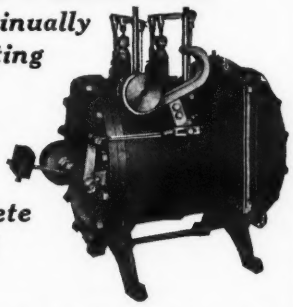

is continually perfecting and developing its complete line of traps

in order to give as care-free operation as science has developed to date

Engineers specify them in all types of industries, hospitals, schools, etc.

Send us your trap problem for us to analyze with you.

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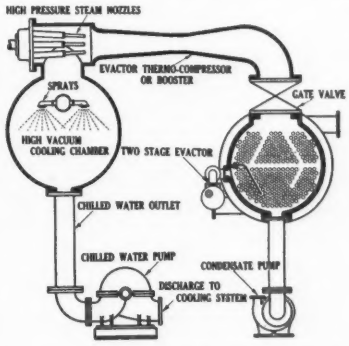

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No moving parts . . . low first cost . . . low operating cost. Ideal for air conditioning, beer cooling, and many other present day requirements. Bulletin on request.

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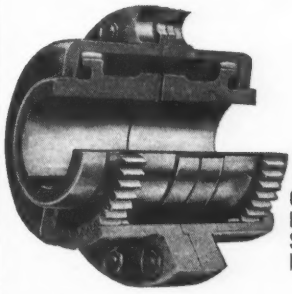

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Self-Aligning
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Send for our coupling catalog P-30, describing our full line of flexible couplings

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Every good valve feature incorporated. This plus Birch betterments increases efficiency, pump capacity and economy, with lessened fuel consumption. Light in weight and strongly made. Economical. Send for descriptive literature.

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WATER COLUMNS and WATER GAGES
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Cut down your fire risk. Avoid danger of "shorts" and "burnouts" in your electrical equipment. Clean out the dust and dirt from your motors, generators and converters with a stream of clean dry air at high velocity. The Clements Blower is instantly convertible for suction cleaning stock bins, etc. Attached to any light socket.

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Run a 30-Day Test FREE

Send for a dozen. See for yourself how they keep motors running, how they quickly pay for themselves in oil saved. If after 30 days' test you don't want them, send them back.

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Guaranteed 10 years or your money back.
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Pressure and gravity INVERSAND zeolite water softeners.
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Chemical feeders for sulphate correction.

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Do Not Break — Do Not Leak

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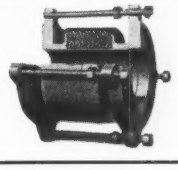

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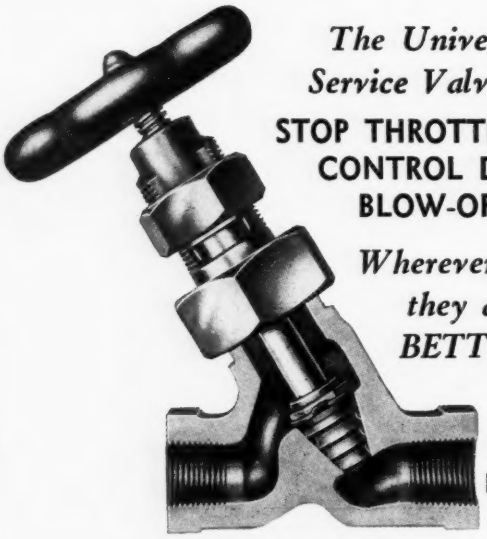
LUDLOW
Multi-Stage Valve



The Universal Service Valve for

STOP THROTTLE
CONTROL DRAIN
BLOW-OFF

Wherever used they are BETTER

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Condensate Outfits

Boiler Feed Pumps

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Self-Priming Pumps

We KNOW that Buffalo Pumps cost LESS to operate—because USERS tell us so. They pay less for repairs—because Buffalo Pumps do not often require them. They, therefore, lose less time due to pumps being shut down. Efficiencies are high—under severe conditions Buffalo Pumps stand up with a minimum of attention.

All these desirable qualities are due to the fact that Buffalo designs are correct—and our workmanship is accurate.

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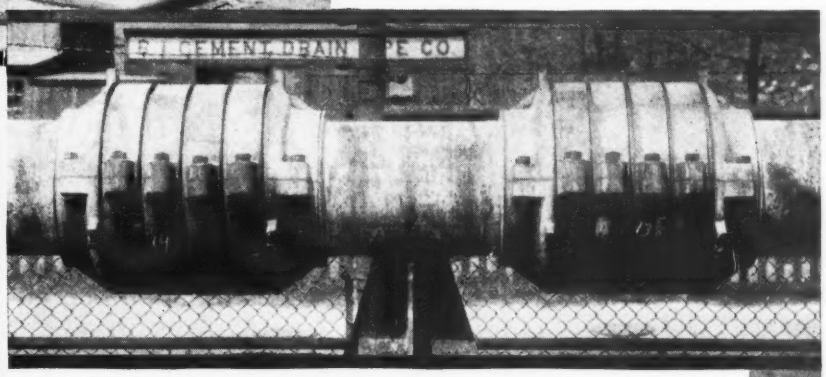
Badger Expansion Joints in a prominent processing plant.

Since Big Utilities Buy Badger Expansion Joints . . . by the Score . . .



The Industrial Plant *needing a few joints* Can Safely Select Badger

The pipe line problems of the big steam distributing companies are but a multiple of those of small industrial plants. Per expansion joint, the requirements are quite similar.

So, if you need only one or two joints, bear in mind that big utilities and prominent engineers make liberal use of Badger Expansion Joints. They like the way maintenance is reduced to a negligible quantity. They like the compactness and controlled and directed action of these joints.

The Directed Flexing feature—exclusive with Badger Joints—is most important. It has added greatly to the life of the joint. Localization of flexing stresses is largely eliminated.

Regardless of number of units needed, the Badger Directed Flexing Expansion Joint is a good buy. It's a useful product that will last for years and require little if any maintenance.

Standard sizes range from 3" to 30". Flanged or welding end types.

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Cleveland, Ohio, Guardian Bldg.
Detroit, Mich., 702 Cadillac Sq. Bldg.
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Kansas City, Mo., 1336 Oak Street
Los Angeles, Cal., 812 Quinby Bldg.
Minneapolis, Minn., 732 Build. Exch.
Montreal, Que., Can. Cement Bldg.
New Orleans, La., 1666 Abundance St.
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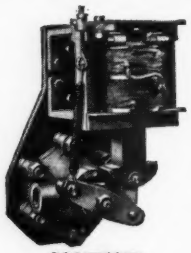
BADGER EXPANSION JOINTS

NICHOLSON THREE *and* FOURWAY VALVES

Lever, Foot and Solenoid Operated

LEVER

FOR operating air, steam, oil or water single and double acting cylinders on all kinds of equipment. Also made in straight-thru and special purpose types.



SOLENOID

Flat disc type, that operates easily and holds tight. For all pressures up to 300 lbs. Write for Bulletins No. 1131, 1132 and 1032 describing types shown.

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W. H. NICHOLSON & CO., 125 Oregon St., Wilkes-Barre, Pa.

FRANCE

Metallic Packings of the better class

Ideal for superheated or saturated steam, ammonia, air or gas, for all pressures and operating conditions. Last 5 to 25 years. Sold on approval.

Write for catalog and list of users.

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Box Numbers in care of our New York, Chicago and San Francisco offices count as 10 words in undisplayed ads. Replies forwarded without additional charge.

Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not proposals).

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SALARIED POSITIONS, $2,500 to $25,000. This thoroughly organized advertising service of 24 years' recognized standing and reputation carries on preliminary negotiations for positions of the caliber indicated, through a procedure individualized to each client's personal requirements. Several weeks are required to negotiate and each individual must finance the moderate cost of his own campaign. Retaining fee protected by a refund provision as stipulated in our agreement. Identity is covered and, if employed, present position protected. If you have actually earned over $2,500, send only name and address for details. R. W. Bixby, Inc., 270 Delward Bldg., Buffalo, N. Y. (P.)

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NATIONALLY known New York manufacturer of engineering specialties desires progressive sales agent, preferably mechanical engineer, for exclusive territory: Georgia, Alabama, Tennessee, Kentucky, Louisiana, Iowa, Colorado. Give qualifications and lines handled. AW-298, Power, 330 West 42d St., New York City.

AGENTS to fill positions in the field served by Power may be secured quickly and economically through an advertisement under this heading.

AGENTS WANTED

WANTED: Progressive sales agent, familiar with oil industry, for exclusive territory vicinity Tulsa, Oklahoma and Fort Worth, Dallas, Houston, El Paso, Texas. Representing old, nationally advertised line engineering specialties. Write giving reference, territory desired. AW-299, Power, 330 West 42d St., New York City.

FREE BULLETIN

REBUILT and guaranteed steam and electrical power equipment offered by The O'Brien Machinery Company of 113 North Third St., Philadelphia, Pa., is listed in a 12-page, 3½x8½ illustrated stock list just issued. Send for Bulletin 933.

WANTED TO HEAR FROM

Manufacturers and Dealers

desiring personal representation in this territory

W. C. BLAIR CO.

428 Dwight Bldg., Kansas City, Mo.

Representation New York City

Highly successful manufacturer's representative, covering 50 miles radius from New York City, with engineering office in best location, desires additional first class account on a commission basis.

RA-265, Power
330 West 42d St., New York City

REPRESENTATION
IN
METROPOLITAN NEW YORK

SALES ENGINEERING CORPORATION desires to represent an established out-of-town concern in the New York territory. We have excellent long established contacts with consulting engineers, industrial, utility, oil and paper companies.

RA-297, Power
330 West 42d St., New York City

Foreign Trade Opportunity

SOVIET RUSSIA

American Engineer, with extensive experience and established engineering business connections throughout Russia, invites correspondence with responsible American manufacturers of power equipment, steam and power plant specialties, special machinery, chemical apparatus, etc. Highest type of permanent trade relations assured. Address

RA-293, Power
330 West 42nd Street, New York City

J. L. HEMPHILL & CO. Inc.

ELECTRICAL ENGINEERS AND EQUIPMENT
801 Williams St. North Bergen, N. J.

N. Y. C. Tel.: LOngacre 5-3227—N. J. Tel.: PAlisade 6-2600

MOTOR GENERATOR SETS

1—500-kw., 250-V., Westinghouse Synchronous motor Generator Set.
2—300-kw., 250-V., 1200-r.p.m., 4100-V., G. E. Synchronous Motors.
1—250-kw., 230-V., 3-ph., 60-cy., 2300-4600 Synchronous Motor Generator Set.
1—200-kw., 230-V., 3-ph., 60-cy., 2300-4100-V. Synchronous Motor Generator Set.
1—200-kw., 125-V., 3-wire, 3-unit Ridgway.
1—150-kw., 600-r.p.m., 250-V. Gen., 3-ph., 60-cy., 220-440-V. G. E. Synchronous Motor.
1—125-kw., 250-V., Westinghouse Synchronous Generator Motor Set, 3-ph., 60-cy., 230-2200-V.
2—125-kw., 125-V., G. E., 2300-V. motor.
1—100-kw., 125-V., D.C., 220-440 A.C. G. E. Synchronous Motor Generator Set.
1—100-kw., 250-V., Gen., 900-r.p.m., 2200-V. Synchronous Motor.
1—50-kw., 230-V., 1200-r.p.m., 220-V. Westinghouse Synchronous Motor.
2—50-kw., 125-V., 1200-r.p.m., 220-V. Westinghouse Synchronous Motors.

ENGINE GENERATOR SETS

3—200-kva. 220/440/600/2300-V. General Electric Ames Uniflow.

TURBINES

1—475-kva. Westinghouse Non-conden.

TRANSFORMERS

4—333-kva. Pittsburgh, 4100/110/220-V.
3—200-kva. G. E., 2400/120/240-V.
4—150-kva. Westinghouse, 2400/120/240-V.
3—100-kva. Westinghouse, 2400/120/240-V.

A. C. GENERATORS

No.	Kw.	R.p.m.	Volts	Ph.	Type
1	400	900	2300–4000	3	Westg.
1	350	600	440	3	Westg.
2	125	900	2300	3	Cr.-Wh.
2	100	900	230-2300	3	G.E.
1	75	600	220	3	Westg
1	75	900	2300	3	G.E.
1	50	1200	220–440–2300	3	G.E.

MOTORS—3-phase, 60-Cycle

No.	Hp.	R.p.m.	Volts	Type
1	800	180	4000	Westghse. Syn.
1	600Kva.	900	440	G.E. Syn. Cond.
1	500	150	2300	Elec. Mach. Syn.
1	500	900	440/4000	Westghse. Syn.
1	500	900	440/2200	G. E. Syn.
1	350	900	2200/4000	Wh. Syn.
2	300	600	445–2300	G. E. syn.
1	250	600	2200/4000	G. E. syn.
1	250	600	220–440	Westg. syn.
1	250	600	440–2200	G. E. syn.
3	200	514	4150–2300	G. E. syn.
2	200	514	2300–4000	G. E. sl. rg.
4	150	1200	220/440	Westg., sl. rg.
1	150	900	2200	G. E. Syn.
2	150	514	2200	Westg., sl. rg.
1	150	1800	2200	West. sq. cg. mfr.
1	100	900	440/2200	G. E. sq. cg.
1	100	900	220–440–220	Westg. sq. cg.

PUMP

1—4,000,000-gal. Water Pump Worthington engine.

Complete Line of A.C. and D.C. Motors and Generators

FOR SALE

MODERN TYPE
Power Plant Equipment

TURBO GENERATOR UNITS
500 to 10,000 kw. each
UNAFLOW GENERATOR UNITS
50 to 1000 kw. each
MOTOR GENERATOR SETS
ROTARY CONVERTERS
TRANSFORMERS
MOTORS

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7th Floor—National City Bank Bldg., Cleveland, Ohio

GREGORY
ESTABLISHED 1893
Hi-Grade Rebuilt

Motors, Generators, Welders, Platers, Converters, Meters, Transformers, Pumps, Exhausters, Blowers, etc. All Standard Makes, Money-Back Guarantee. Latest Rock Bottom Prices.

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GREGORY ELECTRIC CO.
1600 S. Lincoln St. CHICAGO

SPECIAL BARGAIN

1—150-hp. Fairbanks-Morse Type Y three cylinder vertical OIL ENGINE, 257 r.p.m., for belted service complete with gasoline driven air compressor and air bottles and belted to: 1—125 kva., 3 ph., 60 cy., 240 v. GENERATOR.

We also have Steam Engine Units, Turbo Generator Units, Boiler, Air Compressors, etc.

TIPPINS & SPRENGLE, INC.
322 Frick Bldg., Pittsburgh, Pa.

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Financier and Consultant

60 Wall Tower, New York

WANTED

FOR SALE

1—**Engberg Vertical Piston Valve Engine** to 62.5 Kva. Gen. 3/60/240.
1—**Ridgeway Slide Valve** to 125 KW. D.C. 3 wire 120/240.
1—**Ingersoll Imperial** No. 10, 440 ft.
1—84"x20' **H.R.T. Suspended Boiler. A.S.M.E.** 1925—150 lb. W.P.

VALVE & SUPPLY CO., 378 Bedford Ave., Bklyn, N. Y.

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200 HP. DIESEL ENGINE

New De La Vergne, 21 in. dia. cylinder by 34½ in. stroke. Never installed.

Bargain for Quick Sale

MARR-GALBREATH MACHY. CO.
56 Water St., Pittsburgh, Pa.

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TURBO-GENERATOR SET

1—1250 kw. for 450-lb. pressure, 3 ph., 60 cy., 440 v., turbine to bleed at 60 lb. Must be in A-1 condition throughout.

W-296, Power
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SPECIALS
FOR THIS MONTH

200 KW. Westinghouse **Rotary Converter** A.C. End 25 cycle D.C. End 230 volts with Switchboards.
250 H.P. Lincoln **Slipring Motor,** 25 cycle 3 phase 440 volts 480 r.p.m. with new drum, grids and contactor.
150 H.P. General Electric **Motor** 60 cycle 3 phase 220 volts 900 r.p.m.
One Carload of 1- 2- 3- 5-H.P. **Motors,** 60 cycle 3 ph. 220/440 volts 1800 r.p.m.

Write, Wire or Phone for Prices.

Immediate Delivery

Erie Electric Motor Repair Co., Inc.
124 Church Street, Buffalo, N. Y.

Boilers

2—500 H. P. Stirling 200 lb. pres.
1—750 H. P. Stirling 225 lb. pres.
2—350 H. P. Stirling 160 lb. pres.
1—400 H. P. Edge Moor 200 lb. pres.
1—400 H. P. Keeler 160 lb. pres.
23—500 H. P. B. & W. 200 lb. pres.

Also other makes and sizes all A. S. M. E. fine condition. New and used.

J. F. DAVIS
20 N. WACKER DRIVE, CHICAGO, ILL.

WANTED

MOTOR

125 hp., 3 ph., 60 cy. Speed from 300 to 600 r.p.m. Describe fully.

YANKEE HILL BRICK MANUFACTURING COMPANY
Lincoln, Nebraska.

H.M. McCORD

An Industrial Service for Mill and Plant Executives—

LIQUIDATION DEPARTMENT

Offers substantial savings on good Used and Reconditioned

MOTORS Approximately 20,000 H.P. in all sizes from 7½ to 150—the majority averaging from 15 to 40 H.P.—many are wonderful "buys."

TURBINES Good assortment in best makes ranging from 300 to 5,000 K.V.A.

Send for full information

H. M. McCORD

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161 Devonshire St. BOSTON — Commercial Trust Bldg. PHILADELPHIA

Mr. W. G. Pattison, Charlotte, N. C.

AIR COMPRESSOR

1—1050 cu.ft. Worthington 2 stage duplex Horizontal Belt Driven. FEATHER VALVE, with idler, inter cooler and unloader.

PUMPS

2—965 cu.ft. Ingersoll-Rand Class F.R.1 Dry Vacuum Pump. Never used.

BOILER

1—250 hp. Fitzgibbons Self-Contained A.S.M.E. 125 lb. Boiler, used 3 years.

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Engines and Motor Generator Sets

H.R.T. and Water Tube Boilers

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SLIP RING MOTORS, 3-PH., 60-CY.

HP	Volts		Speed
700	2300	G.E.	900
220	220–440	G.E.	450
200	440–220	G.E.	600
150	2200–440–220	G.E.	514
150	2200–220–440	G.E.	720
150	220–440–550	G.E.	600
100	220–440	G.E.	450
100	2200–440–220	Westghse.	1200
100	550	Wagner	720
100	2200–550	Westghse.	900
100	440–220	G.E.	720
100	550	G.E.	900
75	440–220	G.E.	900
50	2200	G.E.	514

SYNCHRONOUS MOTORS, 3-PH., 60-CY.

300	220–440	G.E.	600
240	2200–440–220	G.E.	600
172	2200–440–220	G.E.	720
160	2200–440–220	G.E.	600
120	2200–550	G.E.	900

MOTOR GENERATOR SETS

1—150 kw., 250-275-V., 1200-r.p.m., G.E. connected to 225-kva., 2300-4000-V., 3-ph., 60-cy. synchronous motor.

1—145-kw., 125 V., 900 r.p.m. Westghse., connected to 285 hp., 2400-4100 V., 3 ph., 60-cy. synchronous motor.

1—50 kw., 125 V., 1200 r.p.m., G. E. R.C. connected to KT, 440-220 V., 60-cy., squirrel cage motor.

2—50-kw., 250-V., 1200-r.p.m., G.E. connected to ATI, 440-220-V., 60-cy., synchronous motors.

A.C. GENERATORS

1—250 kva., 600 r.p.m., 240-480 V., G.E.
1—225 kva., 600 r.p.m., 2200–240-480 V., G.E.
1—150 kva., 600 r.p.m., 2200-480-240-V., G.E.
1—112½ kva., 1200 r.p.m., 2300-240-480-V., G.E.
1—112½ kva., 900 r.p.m., 2200-240-480-V., G.E.
1—62½ kva., 1200 r.p.m., 480-240-V., G.E.
1—37½ kva., 1200 r.p.m., 480-240-V., G.E.

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Released by Utilities & Industrials

Turbines, Generators, Steam and Oil Engines, Boilers, Motor Generators, Rotaries, Transformers, Motors, Compressors, etc.

SPECIALS

1,000 Kw. 3-60, G.E. Non Cond. Turbo Generator, late design.
2,000 Kva. 3-60, G.E., Syn., Condenser, 900 r.p.m. with dir. con. exciter
5,000 Kw. Westinghouse Turbo Generator Condensing, 3 phase, 60 cycle, 3,600 r.p.m.

SERVICE BACKED BY 30 YEARS EXPERIENCE

BREW, WOLTMAN & CO.

30 Church Street — **New York City, N. Y.**

BARGAINS

100/150 Hp. Gen. Elec. Dynamometer, complete with scale, switchboard, grids.

368' Ing-Rand Air Compressor, ER-1. Ser. No. 50095, complete like new.

What do you need?

JOHN P. RYAN & COMPANY

144 Grand St., Canal 6-3924, New York, N. Y.

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FOR SALE

At $600.00, loaded on cars at Saranac Inn Station, N. Y., the following machinery in absolutely first-class condition, may be seen in operation.

General Elec. Co. Synchronous Motor No. 309274. Type AT 1. 6—75M, Form P.B., P.F. 85, hp. 75, 3 ph., amp. 200, speed 1200 r.p.m., amp. field 5.6, cy. 60, volts 220, 75 kva., cont. 50 deg. C.

Direct Current Generator No. 1324655. Compound wound Form A, Type RC-35, amp. 217, volts no load 230, speed 1200 r.p.m., volts full load 230, 50 kw., continuous 50 deg. C. General Electric Co.

2—Slate Switchboard Panels.

1—D.C. Slate Panel with main switch rheostat circuit breaker volt motor ammeter.

1—A.C. Slate Switchboard Rheostat and Starting Compensator Voltmeter Ammeter C.R. 1034 Starting Compensator Type No. 6598-N-1 volts P.R.I. 220 for motor kva., 75 volts SNC 77-110, cy., 60, ph. 3. Board complete for A.C. and D.C. motor generator set.

UPPER SARANAC CO., Inc.

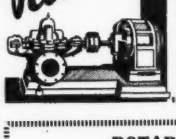
Saranac Inn, N. Y.

Steam Engine Generator Units.
Diesel Engine Generator Units.
Gas Engine Generator Units.
Boilers, and Power Plant Equipment.
Gas Engine Direct Connected Compressors.
Belt Driven Compressors.
Pumps in various sizes.

L. H. BADGER

532 Beacon Life Bldg., Tulsa, Okla.

Rebuilt **PUMPS**



Lawrence, 3 stage, 200 g.p.m. Hill, 3 stage, 600 g.p.m., 325-ft. head. Gould. single stage, 120 g.p.m., 120-ft. head. A.C. or D.C. electrical drive optional.

THE MOTOR REPAIR & MFG. CO.
1556 Hamilton Ave., Cleveland, Ohio

FOR IMMEDIATE SALE!

1—Allis-Chalmers Heavy Duty Corliss Engine, 20x42 in., 100 r.p.m. Box Girder Frame. Left Hand Drive by Fly Wheel Pulley 15 ft. diameter x 35 in.

Extra Long Range Valve Gear to allow 50% cut off. Double Eccentric.

Total Weight 65,000 pounds. Re-bored and new piston and rings installed, also valves re-bored and new valves replaced within two years.

ABBOTT MACHINE CO.

WILTON — **NEW HAMPSHIRE**

ROTARY CONVERTER

500 kw. Westinghouse, 3 phase, 60 cycle generator end, 600 volts, D.C. Automatic switching.

ENGINE GENERATOR SETS
OIL ENGINES, AIR COMPRESSORS

HYMAN-MICHAELS COMPANY

20 N. Wacker Dr. Bldg., Chicago
Ry. Exchg. Bldg. St. Louis, Mo. — 101 West 31st St. New York City

FOR SALE

800-hp., 8 cylinder air injection **Diesel Engine with complete equipment suitable direct connection to any generator.** Speed, up to 450 r.p.m. Price most reasonable, and ready for immediate delivery.

Pump Equipment & Engineering Co.
238 Main St., Cambridge, Mass.
Tel.: Porter 6666-7

BARGAINS IN DIESEL ENGINES

We have a long list of Diesel engines which we can furnish you, but the following are those units which we own and control and are particularly desirous of moving at once.

1—250 Hp. Busch Diesel.
2—120 Hp. Busch Diesel.
1—120 Hp. Bessemer.
1— 90 Hp. Worthington.
2— 60 Hp. De La Vergne.
2— 40 Hp. De La Vergne.

Write or wire us your requirements.

ROBERT P. KEHOE MACHINERY CO.
1 East 42nd St., New York City.

THE EXECUTIVE SECTION of this issue is designed to provide a common language and a common mental meeting ground for the engineer and the non-technical management executive—to smooth the way for closer cooperation between operating and managing elements.

You will benefit through a sounder knowledge of power subjects by your management. Therefore, POWER invites you to send us the names of executives of your company who should read this number. To those executives we will send copies of the issue without cost or obligation.

If you deal in Used Machinery

Material or Equipment

be sure your name appears in the NATIONAL list now being compiled for the distribution (free) of information you will find both valuable and interesting. (No charges of any kind for listing.) Send full details—name, address, officers, type of used items handled, whether from stock, as trade-ins, as a broker, etc.

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Electric Power Equipment

MOTOR GENERATORS

500 kw., 250 v. G.E. to a 3 ph., 60 cy. syn. mtr., with panels.
200 kw., 600 v. Westgh. to a 3 ph., 60 cy., syn motor.
150 kw., 250 v. G.E. to 225 hp. motor.
100 kw., 125 v. Westgh. to 3 ph., 60 cy. syn. motor.
100 kw., 250 v. Westgh. to 3 ph., 60 cy. motor.

ENGINE GENERATORS

200 kw., 3 wire Ames Unaflow.
50 kw., 3-60 G.E. Harrisburg.
75 kva., 3-60 Cr. Wh. Harrisburg.
100 kw., 3-60 G.E. Skinner Unaflow.
156 kva., 2-60 Allis-Chalmers-Skinner Unaflow.
250 kva., 3-60 G.E. Harrisburg Unaflow.
400 kva., 3-60 Westgh. Erie Ball, 4 valve.

WELDERS

1000 amp., G.E. with syn. motor and panels.
400 amp., W.D. Gen. Elec.
200 amp., W.D. Gen. Elec.
200 amp., Westgh.

TURBINES 3 ph., 60 cy.

3750 kva., G.E., cond.
1875 kva., G.E., extraction.
1250 kva., Allis-Chalmers.
1250 kva., G.E., cond.
750 kva., Allis, mixed.
625 kva., G.E., cond.
375 kva., G.E., cond.
375 kva., G.E., non-cond.
125 kva., G.E., cond.
94 kva., Westgh., cond.

PUMPS

3000 G.P.M., Worthington, 300 ft. head to 400 hp. syn G.E. motor.
12-in., 3 stage Midwest, extended base for motor.
1500 G.P.M., Cameron, 8 in. to 20 hp. motor.

MOTORS 3 ph., 60 cy.

700-hp., G.E., syn., 450 r.p.m.
575-hp., West., syn. 180 r.p.m.
450-hp., West., sl. rg., 720 r.p.m.
400-hp., West., syn., 200 r.p.m.
300-hp., West., syn., 200 r.p.m.
300-hp., G.E., syn., 1200 r.p.m.
250-hp., G.E., syn., 1200 r.p.m.
250-hp., Cr.Wh., sl.rg., 585 r.p.m.
200-hp., F.M., syn., 600 r.p.m.
200-hp., Fynn Weichsel, 720 r.p.m.
150-hp., G.E., sl.rg., 720 r.p.m.
150-hp., G.E., sl.rg., 400 r.p.m.
125-hp., G.E., sl.rg., 1200 r.p.m.
110-hp., G.E., syn., 900 r.p.m.
100-hp., West., sl.rg., 875 r.p.m.
92.5-hp., G.E., syn., 900 r.p.m.
80-hp., G.E., sl.rg., 1200 r.p.m.
75-hp., Westgh., 870 r.p.m.
75-hp., West., sl.rg., 900 r.p.m.
75-hp., G.E., 1800 r.p.m.
75-hp., G.E., syn., 900 r.p.m.
75-hp., G.E., 900 r.p.m.
75-hp., G.E., 600 r.p.m.
75-hp., Lincoln, 900 r.p.m.
75-hp., G.E., 720 r.p.m.
75-hp., Cr. Wh., 690 r.p.m.
75-hp., Allis-Chal., 865 r.p.m.
60-hp., Linc. sl.rg., 900 r.p.m.

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30 kw. Gen. Elec. ATB, 1200 r.p.m., 3/60/220.
60 kva. Westinghouse, 1800 r.p.m., 3/60/220.
75 kw. Gen. Elec. ATB, 1200 r.p.m., 3/60/220.
90 kva. Gen. Elec. ATB, 900 r.p.m., 3/60/220.
108 kva. Gen. Elec. ATB, 720 r.p.m., 3/60/440.
125 kva. Westinghouse, 900 r.p.m., 3/60/440.
150 kva. Fair-Morse, 600 r.p.m., 3/60/220.
200 kva. Westinghouse, 600 r.p.m., 3/60/220.
200 kw. Gen. Elec. ATB, 600 r.p.m., 3/60/440.

SYNCHRONOUS MOTORS

30 hp. Gen. Elec. ATI, 1200 r.p.m., 3/60/220.
100 hp. Gen. Elec. ATI, 1200 r.p.m., 3/60/220.
145 hp. Gen. Elec. ATI, 720 r.p.m., 3/60/440.

MOTOR GENERATORS

20 kw. G.E. (R.C.) 500 v. D.C., 110 v. D.C.
50 kw. G.E. (MPC), 125 v. D.C., 3/60/220 v.
60 kw. G.E. (C.D.). 125 v. D.C., 3/60/220..
100 kw. Elec. Machy. 125 v. D.C., 3/60 synch.
150 kw. West. 3-wire, 125/250 v., 900 r.p.m. A.C.
150 kw. G.E., 125 v. D.C., 3/60 cy. synch. Motor.
200 kw. G.E. (MPC), 250 v. D.C., 1200 r.p.m.
300 kw. West., 250 v. D.C., 900 r.p.m. synch. Mtr.

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1—1500 Kw. Gen. Elec. 2-3-60-2300 V.
1—1000 Kw. Gen. Elec. 3-60-600 V.
2— 500 Kw. Gen. Elec. 3-60-2300 V.
2— 500 Kw. Gen. Elec. 3-60-600 V.
1— 300 Kw. G.E. (Non Cond.) 3-60-600 V.

Motor Generators

1—750 Kw. G.E. Syn. 3-60-13,200-275 D.C.
2—200 Kw. West. 3-60-220 to 275 D.C.
1— 75 Kw. G.E. 3-60-2300 to 125 D.C.

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200-hp. West. Slip Ring, 440/220 v., 500 r.p.m.
200-hp. G.E. Synch., 2200/440 v., 514 r.p.m.

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260 kva., 187 and 125 kva. GE-Skinner Uniflow.
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1875 kva. (3) also 600 kva., GE non-condens.
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500 K.W. Gen'l. Elec., 3600 R.P.M., 3 ph., 60 cy., 600/2300 V. Cond'g. 175 lb., 125 Deg. S.H.
200 K.W. Gen'l. Elec., 3600 R.P.M., 3 ph., 60 cy., 2300 V. Non-Cond'g. 125 lb.

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